Rice University

GENERAL ANNOUNCEMENTS

for the

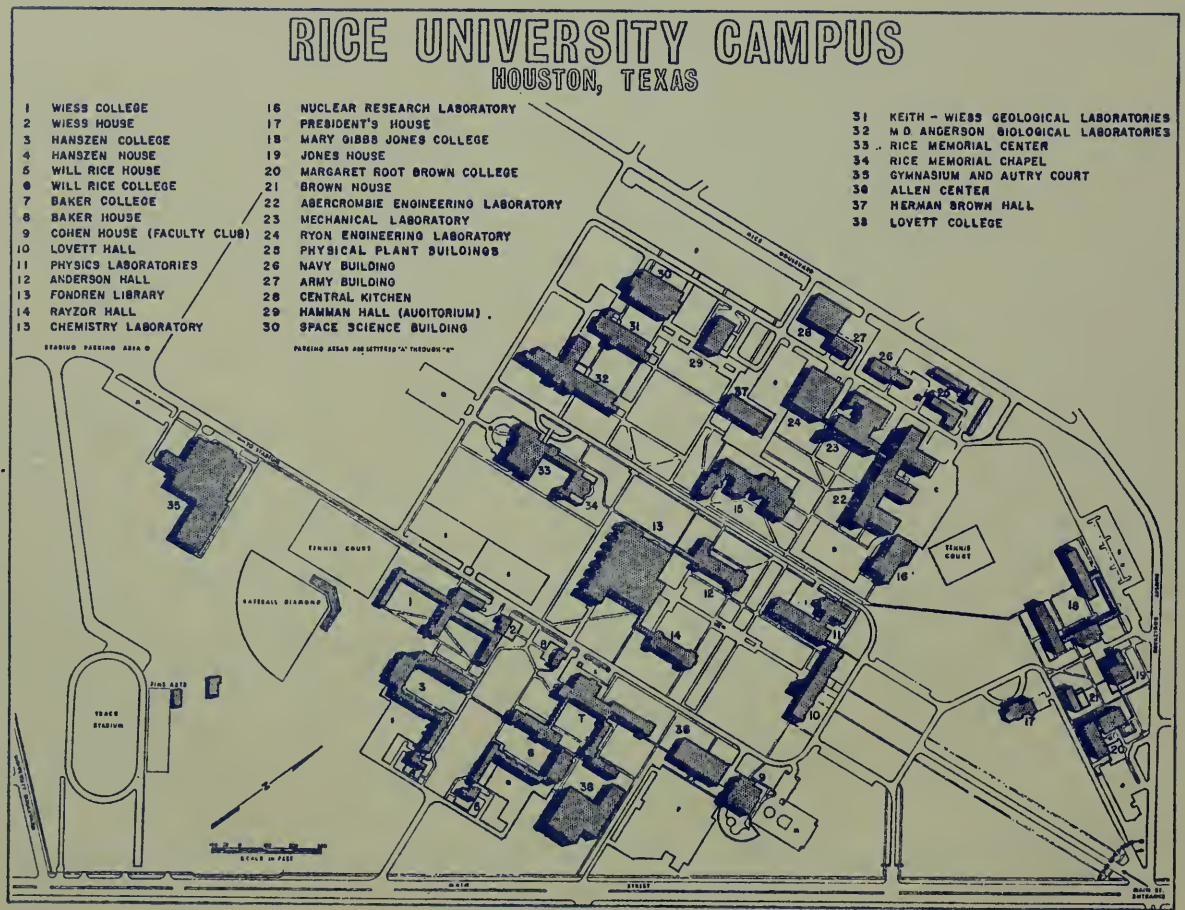
Academic Year 1968-1969

September, 1968

RICE UNIVERSITY CAMPUS

HOUSTON, TEXAS

1 WIESS COLLEGE
2 WIESS HOUSE
3 HANSZEN COLLEGE
4 HANSZEN HOUSE
5 WILL RICE HOUSE
6 WILL RICE COLLEGE
7 BAKER COLLEGE
8 BAKER HOUSE
9 COHEN HOUSE (FACULTY CLUB)
10 LOVETT HALL
11 PHYSICS LABORATORIES
12 ANDERSON HALL
13 FONDREN LIBRARY
14 RAYZOR HALL
15 CHEMISTRY LABORATORY
16 NUCLEAR RESEARCH LABORATORY
17 PRESIDENT'S HOUSE
18 MARY GIBBS JONES COLLEGE
19 JONES HOUSE
20 MARGARET ROOT BROWN COLLEGE
21 BROWN HOUSE
22 ABERCROMBIE ENGINEERING LABORATORY
23 MECHANICAL LABORATORY
24 RYON ENGINEERING LABORATORY
25 PHYSICAL PLANT BUILDINGS
26 NAVY BUILDING
27 ARMY BUILDING
28 CENTRAL KITCHEN
29 HAMMAN HALL (AUDITORIUM)
30 SPACE SCIENCE BUILDING
31 KEITH - WIESS GEOLOGICAL LABORATORIES
32 M.D. ANDERSON BIOLOGICAL LABORATORIES
33 RICE MEMORIAL CENTER
34 RICE MEMORIAL CHAPEL
35 GYMNASIUM AND AUTRY COURT
36 ALLEN CENTER
37 HERMAN BROWN HALL
38 LOVETT COLLEGE

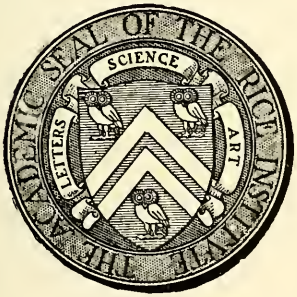


William Marsh Rice University

GENERAL ANNOUNCEMENTS

for the

Academic Year 1968-69



FOUNDED BY WILLIAM MARSH RICE

OPENED FOR THE RECEPTION OF STUDENTS IN THE AUTUMN OF NINETEEN HUNDRED AND TWELVE

DEDICATED TO THE ADVANCEMENT OF LETTERS, SCIENCE, AND ART

Houston, Texas
1968

Contents

Academic Calendar v

Part One. Administration and Staff

Officers of Administration 3
Board of Governors 4
The Rice University Associates 5
The Rice University Research Sponsors 8
The College Masters 9
The Instructional and Research Staff 10
University Standing Committees 38

Part Two. General Information

Historical Sketch of the University 43
The University Campus and Facilities 45
Chairs and Lectureships 47

Part Three. Information for Undergraduates

Curricula and Degrees 53
Reserve Officers' Training Corps Programs 63
Academic Regulations 66
Admission of New Students 71
Tuition, Fees, and Expenses 77
Scholarships and Financial Aid 80
Academic Honors and Awards 88
Student Life 91

Part Four. Information for Graduate Students

General Information 99
Areas of Study and Degrees 99
Requirements for Professional Degrees 100
Requirements for Research Degrees 100
Admission to Graduate Study 102
Tuition, Fees, and Expenses 104
Fellowships, Scholarships, and Prizes 105
Graduate Student Life 108

Part Five. Courses of Instruction 111

Index 245

1968

JULY

S	M	T	W	T	F	S
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AUGUST

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DECEMBER

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ACADEMIC CALENDAR
1968-69

First Semester

Monday, August 26	Last Day for Payment of First Semester Fees, Except for New Students
Saturday, August 31	Arrival of Freshmen
Thursday, September 5	Opening of Courses, 8:00 A.M.
Wednesday, November 27	Beginning of Thanksgiving Recess, 6:00 P.M
Monday, December 2	Resumption of Courses, 8:00 A.M.
Friday, December 13	Last Day of Classes
Saturday, December 14	Last Day for Filing Course Registration for Second Semester
Monday, December 16	Beginning of Examinations

Second Semester

Wednesday, January 2	Last Day for Payment of Second Semester Fees
Monday, January 6	Opening of Courses, 8:00 A.M.
Saturday, March 8	Beginning of Spring Recess, 12:00 NOON
Monday, March 17	Resumption of Courses, 8:00 A.M.
Thursday, April 3	Beginning of Easter Recess, 6:00 P.M.
Tuesday, April 8	Resumption of Courses, 8:00 A.M.
Saturday, April 26	Last Day of Classes
Tuesday, April 29	Beginning of Examinations
Wednesday, May 14	Last Day for Current Students to File Course Registrations for 1969-70
Friday, May 16	Baccalaureate Exercises
Saturday, May 17	Fifty-Sixth Commencement

Summer, 1969

June-July	Teaching Apprentice Session

Part One

Administration and Staff

Officers of Administration
Board of Governors
The Rice University Associates
The Rice University Research Sponsors
The College Masters
The Instructional and Research Staff
University Standing Committees

Officers of Administration

Kenneth Sanborn Pitzer, Ph.D., D.Sc., LL.D.
President

Carey Croneis, Ph.D., LL.D., D.Sc., D.Eng., L.H.D.
Chancellor

William Vermillion Houston, Ph.D., D.Sc., LL.D.
Honorary Chancellor

George Holmes Richter, Ph.D.
Dean of Graduate Studies

William Edwin Gordon, Ph.D.
Dean of Engineering and Science

Virgil William Topazio, Ph.D.
Dean of Humanities and Social Sciences

Michael Vincent McEnany, M.A.
Dean of Undergraduate Affairs

William Wayne Caudill, M.Arch., LL.D.
Director of School of Architecture

Paul Edwin Pfeiffer, Ph.D.
Dean of Students

Hallie Beth Poindexter, Ed.D.
Associate Dean of Students

James Bernard Giles, M.A.
Director of Admissions

James Caddall Morehead, Jr., B.Arch
Registrar

Leo Sam Shamblin
Treasurer

James Redding Sims, Ph.D.
Campus Business Manager

Richard Francis Dini, B.S.
Assistant to the President for Development

Lucian Minor Wilkens, B.A.
Financial Aid Officer

Robert Howard Bunger, B.A.
Assistant to the President

Board of Governors

Trustees

H. Malcolm Lovett, Chairman
Herbert Allen, Vice Chairman
Mrs. William P. Hobby
J. Hugh Liedtke
Jack C. Pollard
H. Gardiner Symonds
James U. Teague

Trustees Emeriti

George R. Brown
Daniel R. Bullard
John S. Ivy
William A. Kirkland
J. Newton Rayzor
Gus S. Wortham

Term Members

E. D. Butcher
Charles W. Duncan, Jr.
J. W. McLean
Ralph S. O'Connor
Haylett O'Neill, Jr.
Harry K. Smith

Governor Advisors

Francis T. Fendley
James W. Hargrove
Howard B. Keck
Wendel D. Ley
Mason G. Lockwood
John W. Mecom
John D. Simpson, Jr.
John R. Suman
Milton R. Underwood
James O. Winston, Jr.
Benjamin N. Woodson

The Rice University Associates

Mr. and Mrs. James S. Abercrombie
Mr. and Mrs. K. S. Adams, Jr.
Mr. and Mrs. Joe L. Allbritton
Mr. and Mrs. Herbert Allen
Mr. and Mrs. W. Leland Anderson
Mrs. Forrest L. Andrews
Mr. and Mrs. Isaac Arnold
Mr. and Mrs. J. Evans Attwell
Mr. and Mrs. Harry G. Austin
Mr. and Mrs. William S. Bailey
Mr. and Mrs. John B. Baird
Mr. and Mrs. James A. Baker, Jr.
Mr. and Mrs. W. Browne Baker
Mr. and Mrs. Paul F. Barnhart
Mr. and Mrs. Edward R. Barrow
Mr. and Mrs. W. O. Bartle
Mrs. Joe D. Beasley
Mr. and Mrs. Henry M. Beissner
Mr. and Mrs. Albert P. Beutel
Mr. and Mrs. John H. Blaffer
Mr. and Mrs. Richard P. Bond
Mr. and Mrs. James C. Boone
Mr. and Mrs. James L. Britton
Mr. and Mrs. Issaac S. Brochstein
Mr. and Mrs. Philip H. Broun
Mr. and Mrs. George R. Brown
Mr. and Mrs. Hart Brown
Mr. D. R. Bullard
Mr. and Mrs. Harold Burrow
Mr. and Mrs. E. D. Butcher
Mr. and Mrs. George A. Butler
Mr. and Mrs. Charles L. Bybee
Mr. and Mrs. John C. Bybee
Mr. and Mrs. Curtis K. Canter
Mr. and Mrs. Allen H. Carruth
Mr. and Mrs. H. Merlyn Christie
Mr. and Mrs. Geo. S. Cohen
Mr. and Mrs. Stewart P. Coleman
Mr. and Mrs. Raymond A. Cook
Mr. and Mrs. Theodore W. Cooper
Mr. and Mrs. John H. Crooker
Mr. and Mrs. John H. Crooker, Jr.
Mr. and Mrs. H. M. Crosswell, Jr.
Mr. and Mrs. Lloyd K. Davis
Mr. and Mrs. Harold Decker
Mr. and Mrs. John M. de Menil
Mr. and Mrs. C. W. Duncan, Jr.
Mr. and Mrs. Edmund M. Dupree
Mr. and Mrs. James A. Elkins
Mr. and Mrs. James A. Elkins, Jr.
Mrs. Joseph W. Evans
Mrs. W. S. Farish
Mrs. William G. Farrington
Mr. and Mrs. Albert B. Fay
Mr. and Mrs. F. T. Fendley
Mrs. Walter W. Fondren
Mr. and Mrs. Charles I. Francis
Mr. and Mrs. J. R. Frankel
Mr. and Mrs. Kenneth Franzheim, II
Mr. and Mrs. Herbert J. Frensley
Mr. and Mrs. Alfred C. Glassell, Jr.
Mr. and Mrs. Richard J. Gonzalez
Mr. and Mrs. J. A. Gray
Mrs. George L. Gudenrath
Mr. and Mrs. Cecil R. Haden
Mr. and Mrs. W. D. Haden, II
Mr. and Mrs. Walter G. Hall
Mr. and Mrs. Charles W. Hamilton
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Mr. and Mrs. Clyde Hargrove
Mr. and Mrs. James H. Hargrove
Mr. and Mrs. Karl F. Hasselmann
Mr. and Mrs. Erwin Heinen
Mr. and Mrs. Wilbur E. Hess
Mr. and Mrs. Maurice Hirsch
Mrs. William P. Hobby
Mr. and Mrs. William P. Hobby, Jr.
Mr. Roy Hofheinz
Miss Ima Hogg

Mr. and Mrs. Oscar F. Holcombe
Mr. and Mrs. John G. Holland
Reverend and Mrs. Harry N. Holmes
Mr. and Mrs. Claude E. Hooton, Jr.
Mr. and Mrs. George F. Horton
Mr. and Mrs. Lynn G. Howell
Mr. Edward J. Hudson
Mr. and Mrs. Roy M. Huffington
Mr. and Mrs. John S. Ivy
Mr. and Mrs. Curtis Johnson, Jr.
Mr. and Mrs. Gaylord Johnson
Mr. and Mrs. John M. Johnson
Mr. and Mrs. Willard M. Johnson
Mr. and Mrs. Howard B. Keck
Mrs. Edward W. Kelley
Mr. and Mrs. Edward Kelley, Jr.
Mr. and Mrs. W. A. Kirkland
Mr. and Mrs. Carl M. Knapp
Mr. and Mrs. Theodore N. Law
Mr. and Mrs. J. Griffith Lawhon
Mrs. J. Sayles Leach
Mr. and Mrs. Louis Letzerich
Mr. and Mrs. Wendel D. Ley
Mr. and Mrs. Max Levine
Mr. and Mrs. J. Hugh Liedtke
Mr. and Mrs. G. Burton Liese
Mr. and Mrs. John W. Link, Jr.
Mr. and Mrs. William R. Lloyd, Jr.
Mr. and Mrs. Mason G. Lockwood
Mr. and Mrs. Otto J. Lottman
Mr. and Mrs. H. Malcolm Lovett
Mr. and Mrs. James M. Lykes, Jr.
Mr. and Mrs. John F. Lynch
Mr. and Mrs. S. Maurice McAshan, Jr.
Mr. and Mrs. O. J. McCullough
Mr. and Mrs. Ralph H. McCullough
Mr. and Mrs. R. Thomas McDermott
Mr. and Mrs. J. W. McLean
Mr. and Mrs. John T. Maginnis
Mr. and Mrs. John F. Maher
Mrs. Francis H. Maloney
Mr. and Mrs. J. Howard Marshall, II
Mr. and Mrs. Harris Masterson, III
Mr. and Mrs. John W. Mecom
Mr. and Mrs. John S. Mellinger
Mr. Leopold L. Meyer
Mr. and Mrs. Frank W. Michaux
Mr. and Mrs. M. E. Montrose
Mr. and Mrs. Dan M. Moody
Mr. and Mrs. Harvin C. Moore
Mr. and Mrs. Stanley C. Moore
Mr. and Mrs. William T. Moran
Mr. and Mrs. Charles E. Naylor
Mrs. Wheeler Nazro
Mr. Fred M. Nelson
Mr. and Mrs. Millard K. Neptune
Mr. and Mrs. Hugo V. Neuhaus, Jr.
Mrs. Mary Moody Northen
Mr. and Mrs. Ralph S. O'Connor
Mr. and Mrs. Gustav M. O'Keiff
Mr. and Mrs. Haylett O'Neill, Jr.
Mr. and Mrs. George A. Peterkin
Mr. and Mrs. Jack C. Pollard
Mr. and Mrs. Edward Randall, III
Mr. and Mrs. J. Newton Rayzor
Mr. Jess Newton Rayzor
Mr. and Mrs. T. R. Reckling, III
Mr. and Mrs. Charles F. Reed
Mr. and Mrs. Fisher Reynolds
Mr. and Mrs. Raymond D. Reynolds
Mr. and Mrs. John F. Riddell, Jr.
Mrs. Edward S. Rothrock
Mr. and Mrs. Clive Runnells, Jr.
Mr. and Mrs. Patrick R. Rutherford
Mr. and Mrs. Fayez Sarofim
Dr. and Mrs. Irving Schweppe, Jr.
Mr. and Mrs. Eddy C. Scurlock
Mr. and Mrs. Frank W. Sharp
Mr. and Mrs. Thomas H. Shartle
Mrs. James L. Shepherd, Jr.
Mr. and Mrs. Stuart Sherar
Mr. and Mrs. E. Joe Shimek
Mr. and Mrs. Irvin M. Shlenker
Mr. and Mrs. John D. Simpson
Mr. and Mrs. Albert K. Smith
Mr. and Mrs. C. Cabanne Smith
Mr. and Mrs. Harry K. Smith
Mr. William A. Smith

Mr. and Mrs. W. McIver Streetman
Mr. and Mrs. M. S. Stude
Mr. and Mrs. John Robert Suman
Mr. and Mrs. H. Gardiner Symonds
Mr. and Mrs. Williston B. Symonds
Mr. Ben Taub
Mr. Henry J. N. Taub
Mr. and Mrs. James U. Teague
Mr. and Mrs. Howard T. Tellepsen
Mr. and Mrs. Russell Thorstenberg
Mr. and Mrs. Wash Bryan Trammell
Mr. and Mrs. Jack T. Trotter
Mrs. P. E. Turner
Mr. and Mrs. David M. Underwood
Mr. and Mrs. Milton R. Underwood
Mrs. Joe Weingarten
Mr. Damon Wells, Jr.
Mr. and Mrs. Wesley W. West
Mrs. Harry C. Wiess
Mr. and Mrs. I. M. Wilford
Mr. and Mrs. Willoughby C. Williams
Mr. and Mrs. Wallace D. Wilson
Mr. and Mrs. James O. Winston, Jr.
Mr. and Mrs. Benjamin N. Woodson
Mr. and Mrs. Sam P. Worden
Mr. and Mrs. Gus S. Wortham
Mr. and Mrs. Andrew Jackson Wray

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Humble Oil & Refining Company

International Business Machines Corporation

International Telephone and Telegraph Corporation

Shell Oil Company

Tenneco Inc.

Texaco Inc.

Union Carbide Corporation

The College Masters

BAKER COLLEGE

Charles William Philpott. B.A., M.S., Ph.D.
Associate Professor of Biology

BROWN COLLEGE

John J. W. Rogers. B.S., M.S., Ph.D. *Professor of Geology*

HANSZEN COLLEGE

Ira Dempsey Gruber. A.B., M.A., Ph.D. *Associate Professor of History*

JONES COLLEGE

Trenton William Wann. A.B., Ph.D. *Professor of Psychology*

LOVETT COLLEGE

Robert Floyd Curl, Jr. B.A., Ph.D. *Professor of Chemistry*

WIESS COLLEGE

Roy VanNeste Talmage. A.B., M.A., Ph.D. *Professor of Biology*

WILL RICE COLLEGE

James Street Fulton. B.A., M.A., Ph.D. *Professor of Philosophy*

The Instructional and Research Staff*

Emeritus Faculty

BATTISTA, JOSEPH LLOYD. *Associate Professor Emeritus of Romance Languages*
Certificat d'Études Françaises (Bordeaux) 1919; Diplôme d'Études Supérieures (Bordeaux) 1919, B.A. (Michigan) 1920; M.A. (Washington University) 1923; M.A. Harvard) 1929

DEAN, ALICE CROWELL. *Librarian Emerita*
B.A. (Rice) 1916; M.A. (Rice) 1919

FREUND, FRIEDRICH ERNST MAX. *Professor Emeritus of German*
Ph.D. (Leipzig) 1902

HARTSOOK, ARTHUR J. *Professor Emeritus of Chemical Engineering*
A.B. (Nebraska Wesleyan) 1911; B.S. in Ch.E. (M.I.T.) 1920; M.S. (M.I.T.) 1921

MORAUD, MARCEL. *Professor Emeritus of French*
Agrégé de l'Université (Paris) 1919; Docteurès Lettres (Paris) 1933

NEELY, JESS CLAIBORNE. *Athletic Director Emeritus*
L.L.B. (Vanderbilt) 1924

NICHOLAS, HENRY OSCAR. *Associate Professor Emeritus of Chemistry*
A.B. (Oberlin) 1919; Ph.D. (Yale) 1923

RYON, LEWIS BABCOCK. *Professor Emeritus of Civil Engineering and Honorary Associate of Hanszen College*
C.E. (Lehigh) 1917

WELSH, HUGH CLAYTON. *Lecturer Emeritus in Biology and Medical Adviser*
M.D. (Texas) 1923

Faculty

ADAMS, JOHN ALLAN STEWART. *Professor of Geology*
Ph.B. (Chicago) 1946; B.S. (Chicago) 1948; M.S. (Chicago) 1949; Ph.D. (Chicago) 1951

AKERS, WILLIAM WALTER. *Professor of Chemical Engineering*
B.S. in Ch.E. (Texas Tech.) 1943; M.S. in Ch.E. (Texas) 1944; Ph.D. (Michigan) 1950

* The Faculty is listed as of July 1, 1968; other staff as of November, 1967.

ALFREY, CLARENCE P., JR. *Adjunct Associate Professor of Biomedical Engineering*
B.A. (Rice) 1951; M.D. (Baylor) 1955

ALHADEFF, ALBERT. *Visiting Lecturer in Fine Arts*
B.A. (Columbia) 1958; M.A. (New York) 1962; M.A. (Germany) 1965

AMBLER, JOHN S. *Associate Professor of Political Science and Faculty Associate of Brown College*
B.A. (Willamette) 1953; A.M. (Stanford) 1954; Certificat d'Études Politiques (Bordeaux) 1955; Ph.D. (California) 1964

ANDERSON, HUGH R. *Assistant Professor of Space Science and Nonresident Associate of Baker College*
B.A. (Iowa) 1954; M.A. (Iowa) 1858; Ph.D. (California Inst. of Tech.) 1961

ANSEVIN, KRYSTYNA D. *Assistant Professor of Biology*
B.S. (Jagellonian) 1950; M.S. (Jagelonian) 1950; Ph.D. (Pittsburgh) 1961

AUSTIN, WALTER JAMES. *Professor of Civil Engineering*
B.S. in C.E. (Rice) 1941; M.S. in C.E (Illinois) 1946; Ph.D. (Illinois) 1949

AUSTIN, WILLIAM HARVEY. *Assistant Professor of Philosophy and Nonresident Associate of Hanszen College*
B.A. (Wesleyan) 1957; B.D. (Yale) 1960; Ph.D. (Yale) 1966

AWAPARA, JORGE. *Professor of Biochemistry and Faculty Associate of Jones College*
B.S. (Michigan State) 1941; M.S. (Michigan State) 1942; Ph.D. (Southern California) 1947

BADNER, MILO D. *Lecturer in Fine Arts*
B.A. (City College, New York) 1959; M.A. (Columbia) 1963

BAHLER, ALAN STUART. *Assistant Professor of Electrical Engineering*
B.S. (Newark) 1957; M.S. (Newark) 1959; Ph.D. (Johns Hopkins) 1966

BAKER, DONALD ROY. *Associate Professor of Geology and Nonresident Associate of Baker College*
B.S. (California Inst. of Tech.) 1950; Ph.D. (Princeton) 1955

BAKER, STEPHEN D. *Assistant Professor of Physics and Nonresident Associate of Wiess College*
B.S. (Duke) 1957; M.S. (Yale) 1959; Ph.D. (Yale) 1963

BAKER, STEWART A. *Assistant Professor of English and Resident Associate of Wiess College*
B.A. (Columbia) 1960; M.A. (Yale) 1961; Ph.D. (Yale) 1964

BANG, THOMAS. *Visiting Assistant Professor of Fine Arts*
B.F.A. (Yale) 1962; M.F.A. (U.S.C.) 1964

BARAC, VLADIMIR E. *Lecturer in English*
M.A. (Texas) 1966

BARKER, J. R. *Assistant Professor of Health and Physical Education and Nonresident Associate of Hanszen College*
B.S. in P.E. (Rice) 1949; M.Ed. (Texas) 1954

BARKER, JOHN CLAUDE. *Assistant Professor of History and Nonresident Associate of Lovett College*
B.A. (Cambridge) 1958; M.A. (Cambridge) 1962; B.D. (Yale) 1963; M.A. (Toronto) 1964; Ph.D. (Toronto) 1967

BARKER, ROSALIND A. *Lecturer in English*
B.A. (Richmond) 1967; M.A. (Yale) 1959; Ph.D. (Yale) 1963

BAUER, FRIEDRICH WELHELM. *Visiting Professor of Mathematics*
Diplom (Frankfurt) 1955; Ph.D. (Frankfurt) 1959

BAUM, ERNEST ROY. *Lecturer in Education*
B.A. (Trinity University) 1956; M.A. (Texas) 1961

BEARDEN, FRANCIS W. *Professor of Health and Physical Education and Nonresident Associate of Will Rice College*
B.S. (Texas Tech.) 1947; M.A. (Columbia) 1949; Ed.D. (Columbia) 1954

BECKMANN, HERBERT W. K. *Professor of Mechanical Engineering*
Dipl. Ing. (Hanover) 1944; Dr. Ing. (Hanover) 1957

BEDFORD, R. WAYNE. *Lecturer in Music*
B.S. (Houghton) 1938; M.A. (North Texas) 1955; Ph.D. (Midwestern) 1950

BELL, DAVID. *Assistant Professor of Mathematics*
B.S. (City College of New York) 1960; Ph.D. (Brown) 1966

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B.A. (San Antonio) 1942; M.Ed. (Trinity University) 1954; Ph.D. (Texas) 1961

YAP, LEONARD YAU-HOCK. *Assistant Professor of Mathematics*
B.A. (Hong Kong) 1960; M.S. (Washington) 1962; Ph.D. (Washington) 1967

YOUNG, RICHARD D. *Associate Professor of Economics and Mathematical Science*
B.A. (Minnesota) 1951; M.A. (Minnesota) 1954; Ph.D. (Carnegie Inst. of Tech.) 1965

Professional Research Staff

ALABASTRO, ESTRELLA B. F. *Research Associate in the Bio-Medical Engineering Laboratory*
B.S. (Philippines) 1961; M.S. (Rice) 1965; Ph.D. (Rice) 1967

ARDEN, RICHARD C. *Postdoctoral Fellow in Chemistry*
A.B. (Princeton) 1962; Ph.D. (Philadelphia) 1967

ARME, CHRISTOPHER. *Research Associate in Biology*
B.Sc. (Leeds) 1961; Ph.D. (Leeds) 1964

ASANO, KOICHI. *Postdoctoral Fellow in Chemical Engineering*
B.A. (Tokyo) 1960; M.A. (Tokyo) 1962; Ph.D. (Tokyo) 1965

AVASTHI, SURGIT. *Postdoctoral Fellow in Chemical Engineering*
B.Sc. (India) 1961; Ph.D. (India) 1967

BEAM, JOHN E. *Research Associate, T. W. Bonner Nuclear Laboratory*
B.S. (Kansas) 1958; A.M. (Harvard) 1959; Ph.D. (Wisconsin) 1966

BETTONEY, GEORGE. *Postdoctoral Fellow in Chemistry*
B.S. (Rochester) 1964; Ph.D. (Oregon) 1967

BHAKAR, BALRAM S. *Research Associate, T. W. Bonner Nuclear Laboratory*
B.S. (Agra University) 1957; M.S. (Aligarh Muslim U.) 1960; Ph.D. (Delhi University) 1965

BLUM, LESSER. *Postdoctoral Fellow in Chemistry*
B.S. (Buenos Aires) 1954; Ph.D. (Buenos Aires) 1956

BROWNING, LUOLIN. *Research Associate in Biology*
B.Sc. (Rice) 1936; Ph.D. (Rice) 1951

CANADA, THOMAS R. *Research Associate, T. W. Bonner Nuclear Laboratory*
B.S. (Indiana) 1962; M.S. (Indiana) 1965; Ph.D. (Indiana) 1967

CHARLU, THARIMALA VENUGOPALA. *Postdoctoral Fellow in Chemistry*
M.Sc. (Rajputana) 1956; Ph.D. (Indian Inst. of Science) 1964

COLLINS JON GERALD. *Postdoctoral Fellow in Chemistry*
B.S. (Brandon, Canada) 1961; Ph.D. (Alberta, Canada) 1966

CROWE, CAMERON M. *Research Associate in Chemical Engineering*
B.Engineering (McGill) 1953; Ph.D. (Cambridge) 1957

DRUM, GEORGE. *Postdoctoral Fellow in Biology*
B.A. (Catawba) 1962; M.S. (Tulane) 1964; Ph.D. (Tulane) 1966

EATHER, ROBERT. *Research Associate in Space Science*
B.Sc. (New South Wales) 1961; Ph.D. (New South Wales) 1965

GUHR, UWE. *Research Associate in Chemistry*
B.S. (Technische Hochschule, Aachen) 1962; M.S. (Technische Hochschule, Aachen) 1964; Ph.D. (Technische Hochschule, Aachen) 1966

HARRIS, BEN. *Postdoctoral Fellow in Biology*
Ph.D. (Oklahoma State) 1966

HASTIE, JOHN WILLIAM. *Postdoctoral Fellow in Chemistry*
B.S. (Tasmania) 1961; Ph.D. (Tasmania) 1967

HATFIELD, L. L. *Research Associate, T. W. Bonner Nuclear Laboratory*
Ph.D. (Arkansas) 1966

HUDSON, PAUL D. *Research Associate in Space Science*
B.A. (Cambridge) 1962; M.S. (Manchester) 1963; Ph.D. (Manchester) 1966

ISSEROFF, HADAR. *Postdoctoral Fellow in Biology*
B.S. (Brooklyn) 1960; M.S. (Purdue) 1963; Ph.D. (Purdue) 1966

JOSEPH, CLAUDE. *Research Associate, T. W. Bonner Nuclear Laboratory*
Ph.D. (Lausanne) 1966

KARAKASHIAN, MARLENE. *Research Associate in Biology*
B.A. (Northwestern) 1955; Ph.D. (California) 1961

KAVANAGH, LAWRENCE D., JR. *Research Associate in Space Science*
B.S. (Notre Dame) 1964; Ph.D. (Rice) 1967

KURFESS, JAMES D. *Research Associate in Space Science*
B.S. (Case Inst. of Tech.) 1962; M.S. (Case Inst. of Tech.) 1963; Ph.D. (Case Inst. of Tech.) 1967

LUTFIYYA, ABDULLAH. *Senior Research Associate in Sociology*
B.A. (Wm. Penn) 1952; M.A. (Michigan State) 1954; Ph.D. (Michigan State) 1960

MAEHLUM, BERNT. *Senior Research Associate in Space Science*
A.B. (Oslo) 1953; M.S. (Oslo) 1955; Ph.D. (Oslo) 1961

MARSAL, JUAN F. *Research Associate in Behavioral Science*
J.S.D. (Barcelona) 1961; M.A. (Princeton) 1964; Ph.D. (Princeton) 1965

MAY, ROBERT. *Postdoctoral Fellow in Chemical Engineering*
B.S. (Texas A&M) 1964; Ph.D. (Rice) 1967

MENDE, STEPHEN BELA. *Research Associate in Space Science*
B.Sc. (London) 1961; Ph.D. (London) 1965

MINKIN, CEDRIC. *Postdoctoral Fellow in Biology*
B.S. (Maine) 1962; Ph.D. (Maine) 1967

MUENOW, DAVID W. *Research Associate in Chemistry*
B.S. (Carleton College) 1961; Ph.D. (Purdue) 1967

MURTY, A. NARASIMHA. *Postdoctoral Fellow in Chemistry*
B.Sc. (Andra) 1957; M.Sc. (Andra) 1958; D.Sc. (Andra) 1963

MURTY, T. S. S. R. *Postdoctoral Fellow in Chemistry*
B.Sc. (Osmania, India) 1957; M.Sc. (Osmania, India) 1959; M.A.(Princeton) 1964; Ph.D. (Pittsburgh) 1967

NIILER, ANDRUS. *Research Associate, T. W. Bonner Nuclear Laboratory*
Ph.D. (Worchester Polytech Inst.) 1966

PICHAT, PHILLIPPE. *Postdoctoral Fellow in Chemistry*
Ph.D. (Faculte des Sciences de Lyon, France) 1966

PRITCHARD, ROBERT E. *Research Associate in Mechanical and Aerospace Engineering and Materials Science*
B.S. (Purdue) 1959; M.S. (Washington) 1964

RAMIREZ, MANUEL. *Research Associate in Behavioral Science*
B.A. (Texas) 1960; Ph.D. (Texas) 1963

REDDY, S. RAGHUPATHI RAMI. *Research Associate in Biology*
M.Sc. (S.V., India) 1961; Ph.D. (S.V., India) 1966

ROSENBERG, THEODORE J. *Research Associate in Space Science*
B.E.E. (City College of New York) 1960; Ph.D. (California) 1965

SANCHEZ, GILBERT. *Postdoctoral Fellow in Biology*
B.S. (New Mexico State) 1961; Ph.D. (Kansas) 1967

SPIGER, ROBERT JOHN. *Research Associate in Physics*
B.S. (Washington) 1962; Ph.D. (Case Inst. of Tech.) 1967

SUNDERMANN, RUDOLF. *Postdoctoral Fellow in Chemistry*
Ph.D. (Cologne) 1966

TERENZI, HECTOR. *Research Associate in Biology*
Licenciado (Buenos Aires) 1961

THREADGOLD, LAWRENCE T. *Senior Research Associate in Biology*
B.A. (Trinity College, Ireland) 1952; Ph.D. (Trinity College, Ireland) 1955

TSAI, MAO JEN. *Postdoctoral Fellow in Chemical Engineering*
B.S. (National Taiwan University) 1962; Ph.D. (Rice) 1967

UY, O. MANUEL. *Postdoctoral Fellow in Chemistry*
B.S. (LaSalle College, Philippines) 1961; Ph.D. (Case Inst. of Tech.) 1966

VELKLEY, DONALD E. *Research Associate, T. W. Bonner Nuclear Laboratory*
B.S. (Kentucky) 1963; M.S. (Kentucky) 1966; Ph.D. (Kentucky) 1967

VON WITSCH, WOLFRAM H. *Research Associate, T. W. Bonner Nuclear Laboratory*
Ph.D. (Heidelberg) 1967

WILSON, PAUL W. *Postdoctoral Fellow in Chemistry*
B.S. (Melbourne) 1963; Ph.D. (Melbourne) 1967

YERGEY, ALFRED L. *Postdoctoral Fellow in Chemistry*
B.S. (Muhlenberg) 1963; Ph.D. (Pennsylvania) 1967

YOUNG, W. *Research Associate in Physics*
B.Sc. (Birmingham, England) 1961; Ph.D. (Birmingham, England) 1965

Professional Staff of the Library

ABRAMS, FREDERICK. *Junior Librarian R.I.C.E.*
B.A. (Florida) 1965; M.L.S. (Emory) 1967

ALLSPACH, ELIZABETH ANN. *Catalog Librarian*
B.A. (Rice) 1960. M.L.S. (California) 1961

BAXTER, SUSANNA GORTON. *Bibliographer*
B.A. (Texas) 1927; M.A. (Texas) 1935; M.L.S. (Texas) 1959

BISHOP, MARTHA. *Catalog Librarian*
Ph.D. (Munich) 1947

BRAND, MARVINE. *Science Librarian*
B.A. (Mississippi) 1946

CRAIG, HARDIN, JR. *Librarian*
A.B. (Princeton) 1929; A.M. (Harvard) 1931; Ph.D. (Harvard) 1937

DEAN, ALICE CROWELL. *Librarian Emerita and Archivist*
B.A. (Rice) 1916; M.A. (Rice) 1919

GARCIA, JOHN. *Acquisitions Research Librarian*
B.A. (Instituto General y Tecnico de Ponteuedra, Spain) 1934; Certificate of law (Universidad de Santiago de Compostela, Spain) 1936; L.S. (Montevideo, Uruguay) 1966

GRAHAM, ROSE. *Acquisitions Librarian*
B.A. (Rice) 1964; S.M. in L.S. (Simmons) 1965

HAMILTON, MARY ALICE. *Gifts and Exchanges Librarian*
B.A. (Rice) 1932

JAMESON, FLORENCE. *Serials Librarian*
B.A.(Rice) 1918

JOHNSON, JOYCE. *Catalog Librarian*
B.A. (Louisiana State University) 1941; B.S. in L.S. (Louisiana State) 1942

LANE, SARAH LOUISE. *Circulation Librarian*
B.A. (Rice) 1919; B.S. in L.S. (Columbia) 1932

LAPPALA, JANE. *Acquisitions Librarian*
B.A. (Wisconsin) 1933; B.L.S. (Wisconsin) 1942

MAYFIELD, JAMES LEE. *Head of Circulation Department*
B.A. (Colorado State) 1958; M.A. in L.S. (Denver) 1960

MCGEEVER, NANCY BOOTH. *Acquisitions Librarian*
B.A. (Rice) 1952; M.S. in L.S. (Catholic University) 1965

O'KEEFFE, RICHARD L. *Associate Librarian*
Ph.B. (Mount Carmel) 1949; M.S. in L.S. (Louisiana State) 1956

PADDOCK, RITA L. *Head, Science Information Services*
A.B. (Western Maryland College) 1960; M.L.S. (Carnegie Inst. of Tech.) 1951

PERRINE, RICHARD H. *Reference Librarian*
B.F.A. (Yale) 1940; M.L.S. (Texas) 1961

REDMON, ALICE JANE. *Acting Head Catalog Librarian*
B.A. (Denver) 1937

REINDL, ELLENE A. *Catalog Librarian*
B.A. (Rice) 1956; M.S. in L.S. (Columbia) 1962

RUECKING, FREDERICK, C., JR. *Head of Data Processing*
B.A. (Texas) 1952; M.A. (Texas) 1955; A.M.L.S. (Michigan) 1963

SILVERSTEEN, SOPHIE. *Catalog Librarian*
B.A. (Rice) 1952; M.S. (Texas) 1954; M.L.S. (Texas) 1964

TURNBULL, PENDER. *Bibliographer and Curator of Rare Book Room*
B.A. (Rice) 1919

UHRIG, SUSIE. *Serials Librarian*
B.A. (Rice) 1927

VERMEULEN, JUNE. *Acquisitions Librarian*
B.A. (Nottingham) 1956

ZIMMERMAN, THOMAS. *Music and Fine Arts Librarian*
B.A. (Free University of Berlin) 1962

ZINGLER, GILBERTA M. *Head of Acquisitions Department*
A.B. (Butler) 1932; B.S. in L.S. (Illinois) 1935

Professional Staff of the Research Computation Laboratory

COLE, CAROL LYNN. *Programmer*
B.A. (Lamar Tech.) 1964

HARRIS, FRED H. *Assistant Director*
B.S. (North Carolina) 1960

HARRIS, G. P. *Administrative Systems Analyst*
B.S. (Baylor) 1955

LANE, JONI SUE. *Senior Programmer*
B.S. (Oklahoma) 1960

PALING, WILLIAM A. *Operations Manager*

PHILLIPS, ANN MORGAN. *Programmer*
B.A. (Texas) 1964

RACHFORD, HENRY H., JR. *Director*
B.S. (Rice) 1945; M.A. (Rice) 1947; Sc.D. (M.I.T.) 1950

SIMON, OLINDA. *Senior Programmer*
B.S. (Virginia) 1963; M.A. (George Washington) 1964

Staff of the Health Service

SKAGGS, RAY HAMILTON. *Medical Director, Student Health Service*
B.A. (Rice) 1942; M.D. (Texas) 1945

SMITH, EDWARD THOMAS. *Athletic Team Physician*
M.D. (Baylor) 1929

Staff of the Athletic Department

BALE, ALLEN MELBERT, *Assistant Coach of Football*

BARTOSH, GILBERT CHARLES. *Assistant Coach of Football*

BOSSONS, ROBERT R. *Assistant Coach of Football*

BRICKELS, ROBERT J. *Assistant Coach of Basketball*

BRUNSON, EMMETT EVANDER. *Business Manager of Athletics and Coach of Track and Field*

DAVIS, ALLEN BAKER. *Coach of Freshman Football and Assistant Basketball Coach*

DAVIS, JOE WALLACE. *Line Coach of Football*

ERFURTH, AUGUST FRED, JR. *Assistant Coach of Track and Field and Concessions Manager*

GIAMMALVA, SAMUEL ANTONE. *Coach of Tennis*

GRIGG, CECIL BURKETT. *Assistant Coach of Football*

HAGAN, HAROLD B. *Head Coach of Football and Director of Athletics*

HESS, JAMES RAY. *Coach of Freshman Football*

KNODEL, DON R. *Head Basketball Coach*

LANZA, NICK. *Assistant Coach of Football*

MAY, JOHN ROBERT. *Assistant Business Manager of Athletics and Assistant Track Coach*

MOORE, CHARLES EDWARD, JR. *Assistant Coach of Football*

NEELY, JESS CLAIBORNE. *Athletic Director Emeritus*

OSBURN, DOUGLAS EDWARD. *Coach of Baseball*

ROTH, BERTRAM. *Band Director*

WHITMORE, WILLIAM ROGERS. *Athletic Publicity Director*

WINBURN, RAY CRITTENTON. *Academic Counselor in Athletics*

University Standing Committees 1968-69

The President is *ex officio* a member of all committees.

Committee on Admissions: Mr. Giles, *chairman;* Messrs. Cheatham, Donoho, Fulton, Horn, Krahl, Matusow, Merwin, Milburn, Morehead, Parish, Ulrich, C. H. Ward, Mrs. Brown, and Mrs. Raaphorst; Jeffrey Hanes, *student consultant;* the Dean of Undergraduate Affairs, *ex officio.*

Committee on Campus Safety: Mr. Franklin, *chairman;* Captain Potter, Messrs. Kobayashi, Parsons, and Van Houten; Daniel King and Robert Howard Wilson, *student members;* Mr. Berling, *consultant.*

Committee on Computers: Mr. Rachford, *chairman;* Messrs. Anderson, Clark, Holt, Lane, Levy, Orvedahl, Resnikoff, Salsburg, Schum, and Sibert; the Dean of Engineering and Science, *ex officio;* Mr. F. Harris and Mr. Ruecking, *consultants.*

Education Council: Mr. McEnany, *chairman;* Messrs. Bearden, Brooks, Bryan, Castaneda, Doughtie, Eisenberg, Hess, Higginbotham, Levin, Shelton, Ulrich, J. B. Wilson, and Wood; the Dean of Humanities and Social Science, *ex officio.*

Committee on Examinations and Standing: Mr. McEnany, *chairman;* Messrs. Brooks, F. M. Fisher, Gruber, Huddle, B. F. Jones, Puppe, and W. F. Walker; the Registrar, *ex officio;* Robert Atherton, *student consultant.* (This committee also serves as the *Professional Advisory Committee.*)

Faculty Council: The President, *chairman;* the Chancellor; the Dean of Graduate Studies; the Dean of Engineering and Science; the Dean of Humanities and Social Science; Messrs. Leland (1969), Rimlinger (1969), Chapman (1970), Sass (1971), Vandiver (1971), and Brotzen (1972).

Graduate Council: Mr. Pitzer, *chairman;* Mr. Richter, *executive officer;* Messrs. Burchfiel, Hyman, Krzyzaniak, Rabson, Spears, Storck, and Wierum.

Humanities Research Council: Mr. Vandiver, *chairman;* Messrs. Kahn, Kolenda, J. A. Ward and Mrs. Raaphorst; the Dean of Humanities and Social Science, *ex officio.*

Committee on the Library: Mr. Leeds, *chairman;* Messrs. Ambler, Copeland, Doughtie, Haymes, Rath, Sibert and Wiest; Ed Douglas, *student member;* Mr. O'Keefe, *consultant.*

The Rice University Marshals: Mr. Freeman, *Chief Marshal,* Messrs. Stewart A. Baker, Carrington, S. H. Davis, Garside, Grob, Harwood, McClellan; Mr. Bunger, *consultant.*

Committee on Outdoor Sports: Mr. Chapman, *chairman;* Messrs. Castaneda, Rorschach, Vandiver; Mr. Rufus King (representative of the R Association); Mr. James A. Williams (representative of the Alumni Association); Mr. James U. Teague (representative of the Board of Governors).

Committee on Religious Activities: Mr. Nielsen, *chairman;* Messrs. Bale, Burrus, Martin, Rimlinger, and Tsanoff; William Goggin and Greg Scharf, *student members.*

R. O. T. C. Committee: Mr. J. A. S. Adams, *chairman;* the Professor of Military Science; the Professor of Naval Science; Messrs. Bowen, Gerhardt, Grob, Rudee, and Wischmeyer; John Zerdecki, *student member.*

Committee on Schedules: Mr. Curl, *chairman;* Messrs. Gruber, Rudee, Sibert, and Young; the Registrar, *ex officio;* Mr. Bunger, *consultant.*

Committee on Scholarships and Awards: Mr. McEnany, *chairman;* Messrs. Garside, Lankford, Mitchell, and Turner, Mrs. Goodman; Mr. Wilkens, *consultant.*

Science and Engineering Research Council: Mr. Brotzen, *chairman;* Messrs. Dessler, Hellums, Levy, Read, and Turner; the Dean of Engineering and Science, *ex officio.*

Committee on Student Financial Aid: Mr. McEnany, *chairman,* Messrs. Besen, Clayton, Giles, Hodges, Pfeiffer, and James L. Wilson; Mr. Wilkens, *consultant.*

Committee on Student Health: Mr. Price-Williams, *chairman;* Dr. Skaggs, *executive officer;* Messrs. Cuthbertson and Eggert, Mrs. Poindexter and Miss Cason; David Gerth, *student member;* the Dean of Students, *ex officio;* the Chairman and the Most Recent Past Chairman of the College Masters, *ex officio.*

Committee on Rice University Studies: Mrs. Drew, *chairman;* Messrs. Camden, Campbell, Cooper, and Mrs. Raaphorst.

Committee on Undergraduate Affairs: Mr. McEnany, *chairman;* Messrs. Milburn, Pfeifer, Sass, Talmage, and Wann, Mrs. Poindexter; Nancy Dietz, Thomas Plant, and Warren Skaaren, *student members;* the Chancellor, *ex officio.*

Committee on the Undergraduate Curriculum: Mr. Margrave, *chairman;* Messrs. Stephen D. Baker, Brotzen, Deans, Kolenda, Resnikoff, Rimlinger, and Schum; Barry Kaplan and Mike Penn Smith, *student members;* the Dean of Undergraduate Affairs, *ex officio.*

Committee on Undergraduate Teaching: Mr. Sass, *chairman;* Messrs. Burrus, Brotzen, Garside, Parish, Philpott, Rorschach, Tsanoff and Wann; Craig Davis and Lee Buddrus, *student members.*

Committee on University Welfare: Faculty Council Representatives: Sass, Vandiver, Brotzen; Messrs. Parsons (1969), Wierum (1969), Duck (1970), Milburn (1970), Burrus (1971), and Clayton (1971).

Part Two

General Information

Historical Sketch of the University
The University Campus and Facilities
Chairs and Lectureships

The University and Its Campus

Historical Sketch of the University

William Marsh Rice University was founded in Houston, Texas, as the William M. Rice Institute by William Marsh Rice. The founder did not live to see the beginning of instruction at the institution, but his ashes rest in the base of a bronze statue by John Angel located in the center of the Academic Court. The Rice Institute became Rice University on July 1, 1960.

The Rice Institute was incorporated in 1891 under a charter permitting large freedom in the organization of a university to be dedicated to the "Advancement of Literature, Science, and Art." The Board of Trustees on December 28, 1907, appointed Dr. Edgar Odell Lovett, professor of mathematics and head of the astronomy department at Princeton University, to be the first president of the Rice Institute. After careful and extended planning, the new university was opened in September, 1912, to an entering class of seventy-seven students. A three-day academic festival was held on October 10-12, 1912, as a formal celebration of the opening. A similar festival on October 10-12, 1962, commemorated the fiftieth anniversary of the University.

Enrollment expanded rapidly during the early years, and by 1924 a policy was established of admitting annually only about 450 undergraduate students. No restriction was placed on the admission of qualified graduate students. Under the Ten Year Plan adopted by the Board of Governors in the summer of 1964, enrollment will be expanded gradually until it reaches approximately 4,000 by 1975, of which approximately 28 per cent will be graduate students. Beginning with the year 1965-66, tuition was charged by the University and a very liberal program of tuition scholarships established to carry out the intention of the Board that no qualified student be denied admission because of inability to pay tuition.

Dr. Lovett, who died in 1957, became president emeritus in 1946, when Dr. William V. Houston, professor of physics at the California Institute of Technology, assumed the presidency. When Dr. Houston retired as president in 1960, Dr. Carey Croneis, provost and professor of geology at Rice, served as acting president. In July, 1961, Dr. Kenneth S. Pitzer, professor of chemistry and dean of the College of Chemistry at the University of California at Berkeley, became Rice's third president and chief executive officer. At that time Dr. Croneis became chancellor and Dr. Houston honorary chancellor of the University.

A new era of rapid development for the University began at the close of World War II. The Board of Trustees developed during the war years a long-range plan based upon the goal of providing especially good training for a limited number of students, "with a well-developed and strong curriculum in the arts and letters and with the emphasis on science and research that is required to meet changing circumstances." These plans were vigorously executed. New departments were added, the faculty was increased from less than seventy to more than two hundred, admission requirements were raised, curricula were revised, and a great expansion was made in graduate study and research. In the academic year 1966-67 there were nearly seven hundred students working for the master's or the doctor's degree. Nearly sixty postdoctoral fellows and research associates were engaged in investigations in the University laboratories.

The University in 1961 made available to the National Aeronautics and Space Administration a site on Clear Lake near Houston for the construction of an $80,000,000 Manned Space Flight Laboratory, and in 1962-63 it established a Department of Space Science at the graduate level to give training in this field.

Following the arrival of President Pitzer, the preparation of a long-range plan for the future of the University was begun by a study committee in 1962. The completed projection was adopted by the Board of Governors on August 19, 1964, under the title of "A Ten Year Plan for Rice University, 1965-1975."

The plan was developed in conformity with the following statement of purpose: "Rice University's goal and aspiration is to be a university of the highest quality serving not only as an educational center of excellence for selected students of high intellectual ability, motivation, and personal qualifications, but also as a center of creativity where new knowledge and new ideas result from research and other scholarly-creative activities." The plan emphasizes the interaction of graduate and undergraduate education and seeks to encourage the "increasing interdependence of teaching and research for students and faculty." To realize these objectives, the faculty will be increased to just under 400 in 1975, and the number of students will be raised to some 4,000 from the present level of about 2,800. Priority is given to the strengthening of the traditional core of academic studies, but the plan also envisions the possible creation at the graduate level of selected professional schools.

Since 1949 the directing body of the University has been the Board of Governors of fifteen members. This consists of the seven permanent trustees and of eight governors appointed by the trustees for staggered terms of four years. A new body, the Rice University Associates, was formed in 1954 to provide a channel for the free exchange of ideas between the faculty and a group of representative citizens with influence in the civic, cultural, and educational affairs of the region.

The University Campus and Facilities

Rice University occupies a spacious and well-kept campus of some three hundred acres on South Main Street about three miles from the center of the city of Houston. There are at present more than thirty major buildings and groups of buildings exclusive of the Rice Stadium. The harmonious proportions of these buildings and their intriguing architectural features combine with the natural beauty of the campus to form a setting of rare charm in which the students and faculty may pursue their respective tasks.

Architectural distinction was an acknowledged goal of the trustees in 1910 when they accepted a general long-range plan prepared by Ralph Adams Cram, which combined beauty and utility and exhibited attractive elements of Italian, French, and Spanish architecture. When the Rice Institute was formally opened in the fall of 1912, the administration building (now Lovett Hall), the mechanical engineering building and powerhouse, and two residential halls for men had been completed—all in a style inspired by the Romanesque of Lombardy. The same style of architecture was exhibited in the physics and chemistry laboratories, two additional residential halls, and Cohen House (the faculty club) erected during the period from 1915 to 1928.

There was little further change in the campus until after World War II, but there has been a spectacular growth in the physical plant since that time as the long-range plans of the trustees began to be implemented. The new buildings are somewhat less ornate than the older ones, but they have all been carefully designed to harmonize with them, and they exhibit architectural excellence in their own right.

Undergraduate Facilities. In the Fondren Library are extensive collections of books and periodicals in the sciences, social studies, technical fields and the humanities with ample reading rooms open to undergraduates for study and recreational reading. Well-equipped laboratories are provided for instruction in the basic sciences, engineering, the social sciences, and architecture. Computers are available for use in various courses when appropriate.

Hamman Auditorium, equipped for both lectures and stage presentations, is the scene of many student productions, lectures by leading scholars, and concerts. In the Rice Memorial Center are the Campus Store, a cafeteria, and recreational facilities as well as offices of the alumni association, the placement bureau, and the student government and publications. Each of the residential colleges on the campus contains lounges, a dining room, and residential areas. Adja-

cent to each is the residence of the Master of the College and his family. Complete gymnasium facilities are open to all students.

Graduate Facilities. Modern, well-equipped laboratories and libraries provide excellent opportunities for research in many fields. The biology, chemistry, geology and physics laboratories are each housed in a separate building providing space and equipment for research in several areas. The Bonner Nuclear Research Laboratories contain a six-million-volt Van de Graaff generator and a twelve-million-volt Van de Graaff tandem generator. The Laboratory for Space Science also houses research in materials science, metallurgy, and astronautical engineering, in addition to the modern facilities of the Abercrombie Engineering Laboratories and the Ryon Engineering Laboratory. Herman Brown Hall, to be opened in 1968, will provide additional space for mathematics and for systems research in engineering and various sciences.

The Fondren Library houses more than 525,000 volumes (not including microforms, of which there are more than 275,000 units). This figure represents adequate collections of basic materials in history, literature, philosophy, German, French, Spanish, economics and the behavioral sciences, as well as in science and engineering. Several notable research collections are owned, including Civil War imprints, broadsides and manuscripts, Austrian history and literature, the Axson Collection of Restoration and Eighteenth Century plays, German language and literature, and extensive microform holdings of early American publications. A Graduate Library, to be completed in 1968, will increase the total stack capacity to about 1,000,000 volumes; provide additional offices, carrels, and seminar rooms for the use of graduate students and faculty as well as a Graduate and Faculty Research Center where rare books, manuscripts and other special materials will be housed; and add capability for expanding and extending a system of library computer applications already well served by the presence of a library-housed computer.

Chairs and Lectureships

Throughout its history, Rice University has been especially fortunate in the number of its friends and benefactors. Some of these are memorialized in the names of buildings and special physical facilities; others have generously provided for the enrichment of the University's intellectual life by establishing chairs and lectureships either on temporary or permanent bases. Rice takes pleasure in recognizing on these pages some of these contributors to its academic excellence.

The Brown and Root Chair of Engineering

The Halliburton Education Foundation established the Brown and Root chair in 1965. The first appointment was made in November, 1965.

The Louis Calder Professorship in Chemical Engineering

This professorship was endowed by the Louis Calder Foundation in 1966. The first appointment was made in 1967.

The Reginald Henry Hargrove Chair of Economics

The Hargrove chair was established in 1958 in memory of Mr. Hargrove by Mrs. R. H. Hargrove and the Texas Eastern Transmission Corporation. The Hargrove Professor took up residence in 1959.

The William Pettus Hobby Chair in American History

The Hobby Chair was established in 1967 by the Hobby Foundation to honor the late Honorable William P. Hobby, former Governor of the State of Texas.

The Jesse H. Jones Professorship in Management

In 1966 Houston Endowment, Inc. established a fund for the creation of the Jesse H. Jones Professorship in Management in honor of the late Mr. Jones, who was a prominent Houston philanthropist and friend of Rice.

The Mary Gibbs Jones Professorship in History

Houston Endowment, Inc. established this Professorship in History in 1966 to honor the late Mrs. Mary Gibbs Jones, a friend and benefactor of the University.

The Edgar Odell Lovett Professorship in Mathematics

Through the generosity of the Brown Foundation the Edgar Odell Lovett Professorship in Mathematics was established in 1966, honoring the University's first president.

Chairs of Instruction Established by Mrs. Mamie Twyman Martel

A bequest by Mrs. Mamie Twyman Martel provides for four chairs of instruction in fields of humanistic study. Support for two chairs was begun in September, 1962; the Henry S. Fox, Sr., Chair of Instruction in Economics and the Lena Gohlman Fox Chair of Instruction in Sociology. It is expected that the two additional chairs of instruction will be established in the future when sufficient funds become available.

The Harris Masterson, Jr., Chair in History

The late Reverend Harris Masterson, Jr., was deeply interested in Rice University through his activities as director of Autry House and his close personal association with Rice students through many years. His will provided a bequest to the University with which the Board of Governors established a memorial to him in this chair.

Moody Foundation Chairs

In 1964 the Moody Foundation established the Libbie Shearn Moody Professorship of English and the W. L. Moody, Jr., Professorship of Mathematics.

The J. Newton Rayzor Chair in Philosophy and Religious Thought

This chair was established in 1953 by Mr. J. Newton Rayzor, a trustee of Rice University. Its purpose is to provide in the Rice curriculum for distinguished instruction in religious and philosophical ideas which have powerfully influenced the history of civilization.

The David Rice Chair in Ethics

This chair was established in 1967 and is supported by the William Stamps Farish Fund. It honors David Rice, a nephew of the founder, William Marsh Rice.

The Albert Thomas Chair of Political Science

A gift from the Brown Foundation created the Albert Thomas chair in 1965 honoring the late Congressman Albert Thomas.

The Isla and Percy Turner Professorship in Biblical Studies

This professorship was endowed by the Turner Charitable Foundation in 1967.

The William Ward Watkin Chair in Architecture

The Watkin Chair in Architecture was established in 1958 to honor William Ward Watkin, the first Chairman of the Rice Architecture Department.

The Robert A. Welch Chair in Chemistry

The Robert A. Welch Foundation, in advancing the cause of basic chemical research in the Southwest, endowed a professorship in chemistry which was first filled in 1963.

The Harry Carothers Wiess Chair of Geology

In 1952 Mrs. Olga Keith Wiess gave a substantial endowment to the University for the establishment of a chair of geology to be named in memory of her husband, late Vice Chairman of the Board of Governors of the University, in recognition of his profession and of his distinguished service to the University. Work in this department was inaugurated at both graduate and undergraduate levels in 1954.

The Bartlett Aesthetics Program

Chamber music concerts and lectures have been sponsored from time to time by Dr. and Mrs. H. L. Bartlett. The first three Bartlett Lecturers were Dr. Theodore Green, D. Iredell Jenkins, and Dr. Radoslav A. Tsanoff.

The Rockwell Lectures

These lectures are made possible by the Rockwell Fund, Inc. They were inaugurated by Sir Robert Alexander Falconer in April, 1938. Among the distinguished lecturers in the series have been Dean Roscoe Pound, Professor William Ernest Hocking, Dr. Ralph W. Sockman, Dr. George A. Buttrick, Professor Charles W. Hendel, Professor Kenneth S. Latourette, Mr. Charles P. Taft, Dr. Henry P. Van Dusen, Dr. Conyers Read, Professor Theodore Greene, Dr. Joseph Sittler, Dr. J. W. F. Albright, Dr. Julian N. Hartt, Dr. Paul Ricoeur, and Dr. Albert Outler.

The Shepherd School of Music

Mrs. Sally Shepherd Perkins of Asheville, North Carolina, provided in 1950 for the establishment of a school of music at the University. It is contemplated that when the income from this endowment is of sufficient size, appropriate buildings and other facilities will be provided for outstanding instruction in musical theory and appreciation. At present, income from the gift maintains a professorship and a number of courses and activities in music.

The Rice University Lectures

From time to time Rice University invites scholars of distinction to lecture for varying periods. In most cases these lectures are open to the public as well as to the faculty and students.

The Rice Television Series

For over a decade Rice University has presented a series of programs in cooperation with KTRK-TV, Houston. Various aspects of research in science, engineering, and the humanities at the University are discussed, as well as other topics of interest to the community.

Part Three

Information for Undergraduates

Curricula and Degrees
Reserve Officers' Training Corps Programs
Academic Regulations
Admission of New Students
Tuition, Fees, and Expenses
Scholarships and Financial Aid
Academic Honors and Awards
Student Life

Curricula and Degrees

Rice University offers baccalaureate degrees in arts and sciences, engineering, architecture, accounting, commerce, and health and physical education. Students completing the requirements for the Bachelor of Arts degree with outstanding records are given recognition with a designation of *summa cum laude, magna cum laude,* or *cum laude* when the degree is awarded. Majors may be taken in anthropology, architecture, art and history of art, behavioral science, biochemistry, biology, chemical physics, chemistry, classics, economics and business administration, English, French, geology, German, history, mathematics, philosophy, physics, political science, psychology, sociology, or Spanish. The Bachelor of Arts degree is also awarded on successful completion of four-year curricula in chemical engineering, civil engineering, electrical engineering or mechanical engineering, which may be followed by a one-year integrated program terminating in a professional Master's degree or standard graduate programs leading to the Master of Science or Doctor of Philosophy degree. (See pp. 99-104.) The course of study in architecture is of five years' duration and leads to the degree of Bachelor of Architecture; the Bachelor of Arts is conferred upon those who have satisfactorily completed the first four years in this curriculum. A five-year program in accounting leads to a Bachelor of Science degree in that field; those who have completed the first four years in this curriculum receive the Bachelor of Arts degree. The degrees of Bachelor of Commerce and Bachelor of Science in Health and Physical Education are awarded after four years of study in their respective curricula. A program of teacher training within the undergraduate curricula may be followed by those interested in teaching in the secondary schools. Similarly, programs satisfying requirements for admission to dental, medical, and law schools are available.

Honors Programs are offered for especially qualified students in several major fields of study in the academic and science areas. By various methods—small classes and seminars in which student participation is emphasized, close contact with the faculty in methods of research, and extra reading and summer research projects—a student who qualifies for an Honors Program will be able to accelerate study in his major field and perhaps, in some cases, enter graduate study with advanced standing while earning an honors designation on receipt of the Bachelor of Arts degree.

Courses of Study

Undergraduate Programs

During their first two years the students are registered in the five basic curricula–humanities and social sciences (academic), science-engineering, architecture, commerce, and health and physical education. A considerable part of the work is prescribed during these two years, but throughout his four-year course each student pursues a broad program in the fundamental sciences and humanities rather than a narrow course of specialization. In each of the last two years, however, the schedule of every student must be approved by his department of specialization.

To assure that students will distribute choices of electives over an adequate range of subjects, courses are divided into three groups, and certain minimum requirements are specified in each group. The groups are:

Group A—architecture, classics, English, fine arts, foreign languages, history, humanities, music, and philosophy

Group B—anthropology, economics and business administration, education, linguistics, political science, psychology, and sociology

Group C—biology, chemistry, engineering, geology, mathematics, and physics

Teacher Certification. Programs of study are offered to fulfill the Texas State requirements for teaching certificates on the secondary level in biology, chemistry, English, French, general science, German, health and physical education, history, Latin, mathematics, physics, social studies, and Spanish. See page 151 for details.

Predmedical and Prelaw Studies. Courses required for admission to any accredited American medical or law school can be met by proper selection of electives in any curriculum of the University. Interested students are encouraged to seek information and advice about courses and procedures from the Dean of Undergraduate Affairs.

Academic Division

Humanities and Social Sciences

Majors are offered in Group A courses in art and history of art, classics, English, French, German, history, philosophy and Spanish. In Group B majors are available in anthropology, behavioral sciences, economics and business administration, political science, psychology and sociology. A major in biology, geology or mathematics may be taken in either the academic division or the science-engineering division.

Forty courses, each of at least three semester hours, or the equivalent, must be passed to satisfy the requirements for the Bachelor of Arts degree. The specific requirements of both semesters of the first two years are detailed below followed by a general statement of the requirements of the third and fourth years.

First Year

(1) **English 100a, b.** Introduction to Critical Reading, Thinking and Writing
(2) **History 100a, b.** Europe since 1500 or **History 110a, b.** American History
(3) Foreign Language*
(4) **Mathematics 101a, b.** Fundamental Concepts of Mathematics or **Mathematics 100a, b.** Elementary Analysis
(5) **Biology 100a, b.** General Biology or **Chemistry 120a, b.** Introductory and Analytical Chemistry, or **Geology 200a, 201b.** Physical and Historical Geology, or **Physics 101a, b.** Introductory Survey of Physics, or **Physics 100a.** Mechanics **and 100b.** Introductory Relativity and Electricity and Magnetism
(6) Basic Health and Physical Education
(7) R.O.T.C., if elected

NOTE: Either the mathematics or science course may be postponed until the second or third year and a general Humanities course substituted.

Second Year

(1) Science or Mathematics
(2) Group A Elective
(3) Group B Elective
(4) Foreign language or elective*
(5) Elective
(6) R.O.T.C., if elected

NOTE: A second year student may not take more than two courses in one department in any semester.

* Students majoring in a Group A subject must attain a level of competence equivalent to completion of a third-year college course in a foreign language. Those majoring in a Group B or C subject, who wish to continue a foreign language started in high school, must attain third-year level of competence; if the student begins a new foreign language in his freshman year, however, he is required to attain a second-year level of competence. Students wishing to continue study of a foreign language started in high school must take the qualifying examinations offered during Freshman Week.

Third and Fourth Years

Twenty courses are required of at least three semester hours each, including four in Group A and four in Group B. At least fourteen of the twenty courses must be advanced (numbered 300 or higher). Not less than six nor more than ten of the third- and fourth-year

courses and not more than twelve of the total courses offered in fulfillment of the requirements for the degree may fall within a student's major field.

At the discretion of his major department, a student in R.O.T.C. may substitute military science or naval science courses for one of the requirements in each semester of the last two years, except that substitution may not be made in the same elective group both years. For example, a student is not permitted to substitue military science or naval science for all Group A electives.

Fifth Year in Accounting

The fifth year of the professional accounting program is open to all Rice students, including those who major in fields other than economics and business administration, who take the prerequisite undergraduate accounting courses and are seeking intensive preparation for careers in or related to professional accounting.

In the fifth year, ten semester-courses are required: six in accounting, two in economics, and Political Science 310a and b (Law and Society), if not previously taken. The accounting courses cover managerial accounting, auditing, federal taxes, quantitative methods, and accounting theory. The degree awarded is the Bachelor of Science in Accounting.

Students planning to enter this program should consult the Department of Economics and Business Administration for further information, including details on the prerequisite undergraduate accounting courses.

Science-Engineering Division

Science and Mathematics

Students majoring in science register in the basic science-engineering curriculum specified below in the first two years. Before selecting electives in the Sophomore year, the student should seek advice from the chairman of the department of his intended major.

In the Junior and Senior years specific requirements in the major field and in related subjects are determined in consultation with an appointed adviser in the appropriate department. The student's registration in each of these years must be approved by his adviser.

First Year

(1) **Mathematics 100a, b.** Analysis or **Mathematics 220a, b.** Advanced Analysis
(2) **Physics 100a.** Mechanics, and **Physics 100b.** Introductory Relativity and Beginning Electricity and Magnesium.
(3) **Chemistry 120a. b.** Introductory and Analytical Chemistry

(4) **History 100a, b.** Europe since 1500 or **History 110a. b.** American History
(5) **English 100a, b.** Introduction to Critical Reading, Thinking and Writing
(6) Basic Health and Physical Education
(7) R.O.T.C., if elected

Second Year

(1) Advanced Analysis
(2) Second Year Physics
(3) Group A elective
(4) Foreign Language, or elective*
(5) Elective*
(6) R.O.T.C., if elected

* Before registering for second year courses each student should consult with an advisor in his proposed major department concerning appropriate electives and foreign language. Each student is required to attain a level of competence equivalent to completion of a second year college course in a foreign language. Students wishing to continue study of a foreign language started in high school must take the qualifying examinations offered during Freshman Week. Students who qualify for a second year course on the basis of this examination may postpone History until the second year in order to continue study of the language without interruption.

Third and Fourth Years

Science majors are available in biochemistry, biology, chemical physics, chemistry, geology, mathematics, and physics. A major in biology, geology, or mathematics may also be taken in the academic division.

Twenty courses (or equivalent) are required of at least three semester hours, including at least eight in the major field of study, four in Group C outside the major field, and of the remaining courses, four must be chosen from Group A or B. Fourteen of these twenty courses must be advanced (numbered 300 or higher). Not more than twelve of the total courses in fulfillment of the requirements for the Bachelor of Arts degree may fall within the major field.

At the discretion of his major department, a student in R.O.T.C. may substitute military science or naval science courses for one of the requirements in each semester of the last two years.

Engineering

During the first two years students with an interest in engineering register in the basic science-engineering curriculum. They should consult with the chairman of the department of interest or the Dean of Engineering and Science for information and advice about details of the program and choice of electives, and about engineering as a profession. In each of the third and fourth years every student's registration must be approved by an adviser in his major department.

On completion of the Bachelor of Arts degree at the end of the fourth year the student is expected to have a firm foundation in basic engineering principles and fundamental sciences and a broad understanding of the humanities. All students desiring admission to fifth-year studies leading to the professional master's degree must apply to the Committee on Professional Master's Degrees. Students transferring from other institutions or from other courses of study within the University who have not completed work equivalent to the first four years of the Rice University engineering curriculum must also submit transcripts of all previous work with their application for admission. Acceptance or rejection is determined after consideration of past academic performance and the recommendation of the department concerned.

First Year

(1) **Mathematics 100a, b.** Analysis or **Mathematics 220a, b.** Advanced Analysis
(2) **Physics 100a.** Mechanics, and **Physics 100b.** Introductory Relativity and Elementary Electricity and Magnetism.
(3) **Chemistry 120a, b.** Introductory and Analytical Chemistry
(4) **History 100a, b.** Europe since 1500 or **History 110a, b.** American History
(5) **English 100a, b.** Introduction to Critical Reading, Thinking and Writing
(6) Basic Health and Physical Education
(7) R.O.T.C., if elected

Second Year

(1) **Mathematics 200a, b., 210a, b.,** or **220a, b.** Advanced Analysis
(2) **Physics 210a.,** or **Physics 200a.** Electricity and Magnetism, and Elective*
(3) Elective*
(4) Elective A or B
(5) Foreign language or elective**
(6) R.O.T.C., if elected

* Departmental recommendations: Civil and Mechanical Engineering (Engr. 200b, Engr. 211a, Engr. 212b, Engr. 240a, Engr. 241b); Chemical Engineering (Engr. 211a, Engr. 212b., Engr. 240a, Engr. 241b, Phys. 210b); Electrical Engineering (Engr. 200b, Engr. 240a, Engr. 241b, Phys. 210b)

** Each student is required to attain a level of competence equivalent to completion of a second year course in a foreign language, or of first year competence in two foreign languages. Students wishing to continue study of a foreign language started in high school must take the qualifying examinations offered during Freshman Week. Students who qualify for a second year course on the basis of this examination may postpone History until the second year in order to continue study of the language without interruption.

Third and Fourth Years

Twenty courses are required, each of at least three semester hours, for the completion of the Bachelor of Arts degree, fourteen to be in

Group C and four chosen from Groups A or B. The others are undesignated. At least fourteen courses must be advanced (numbered 300 or higher).

At the discretion of his major department, a student in R.O.T.C. may substitute military science or naval science courses for one of the requirements in each semester of the last two years.

School of Architecture

Successful completion of the first four years of the curriculum qualifies the candidate for the Bachelor of Arts degree. Upon satisfactory completion of the requirements of the fifth year, the degree of Bachelor of Architecture is awarded by the University.

First Year

(1) **Architecture 101a, 102b.** Principles of Architecture
(2) **Mathematics 100a, b.** Elementary Analysis or **Mathematics 101a, b.** Fundamental Concepts of Mathematics
(3) **Physics 101a, b.** Introductory Survey of Physics or **Physics 100a.** Mechanics and **100b.** Introductory Relativity and Electricity and Magnetism*
(4) **English 100a, b.** Introduction to Critical Reading, Thinking and Writing
(5) **History 100a, b.** Europe since 1500 or **History 110a, b.** American History*
(6) Basic Health and Physical Education
(7) R.O.T.C., if elected.

Second Year

(1) Principles of Architecture II
(2) Ancient Art
(3) Drawing I
(4) Elective, not in Art or History of Art**
(5) Foreign Language*
(6) R.O.T.C., if elected

* Students wishing to continue the study of a foreign language started in high school must take the qualifying examinations offered during Freshman Week. Such students who qualify for a second year course may postpone either Physics or History until the second year in order to continue study of the foreign language without interruption.

All students are required to attain a level of competence equivalent to passing a second year college course in a foreign language.

Third Year

(1) Principles of Architecture III
(2) Drawing II
(3) Elective
(4) Foreign languages or elective in Group A, B, or C**
(5) R.O.T.C., if elected**

Fourth Year

(1) Principles of Architecture IV
(2) Sculpture I
(3) Medieval Art
(4) Elective in Group A, B, or C**
(5) R.O.T.C., if elected**

** At least two semester-courses of electives chosen must be in Group B. R.O.T.C. may be chosen for one of the electives in the third or fourth year.

Fifth Year

(1) Principles of Architecture V
(2) Renaissance and Baroque Art
(3) Elective in Group A, B, or C

Program in Commerce

With the approval of the department chairman appropriate courses in the science-engineering and academic curricula may be substituted for required commerce courses. Fourteen of the twenty courses of the last two years must be numbered 300 or higher. Not less than six nor more than twelve of the total courses offered in fulfillment of the degree requirements may be in commerce. With the approval of the department chairman, students in R.O.T.C. may substitute military science or naval science courses for one of the requirements each year, but two substitutions may not be made in the same subject or group, as, for instance, the foreign language or Group B.

First Year

(1) **Commerce 110a, b.** Business Mathematics, **Mathematics, 100a, b.** Elementary Analysis, or **Mathematics 101a, b.** Fundamental Concepts of Mathematics
(2) **History 110a, b.** American History
(3) **English 100a, b.** Introduction to Critical Reading, Thinking and Writing
(4) Foreign language*
(5) Science elective
(6) Basic Health and Physical Education

Second Year

(1) **Commerce 210a, b.** Introduction to Business
(2) Group A elective
(3) Foreign language*
(4) Group B elective
(5) Laboratory science or mathematics elective

* Each student is required to attain a level of competence equivalent to completion of a second year college course in a foreign language. Students wishing to continue study of a foreign language started in high school must take the qualifying examinations offered during Freshman Week.

Third Year

(1) **Commerce 300a, b.** Financial Control
(2) **Commerce 310b.** Business Statistics; **Commerce 315a.** Finance and Banking
(3) Group A elective
(4) Group B elective
(5) Free elective

Fourth Year

(1) **Commerce 410a.** Marketing; **Commerce 415b.** Business Finance
(2) **Commerce 420a.** Business Organization I; **Commerce 425b.** Business Organization II
(3) Law and Society
(4) Group A elective
(5) Free elective

Program in Health and Physical Education

First Year

(1) **History 110a, b.** American History
(2) **English 100a, b.** Introduction to Critical Reading and Writing
(3) Foreign language*
(4) Mathematics
(5) Science
(6) **H.&P.E. 103-4.** Basic Health and Physical Education

Second Year

(1) Science or Mathematics (**Biology 100** required)
(2) Group A elective
(3) Group B elective
(4) Foreign language or Elective*
(5) **H.&P.E. 100a.** Foundations of Physical Education and **H.&P.E. 110b.** Foundations of Health Education
(6) **H.&P.E. 225a-226b.** Laboratory

* Each student is required to attain a level of competence equivalent to completion of a second year college course in a foreign language. Students wishing to continue study of a foreign language started in high school must take the qualifying examinations offered during Freshman Week.

Third Year

(1) **H.&P.E. 200a.** Principles and Philosophy of Physical Education in the United States and **H.&P.E. 210b.** Intramural Sports, School-Community Recreation Programs, and Safety Education
(2) **H.&P.E. 300a.** Kinesiology and **H.&P.E. 310b.** Methods, Materials, and Curriculum Construction in Physical Education and Interscholastic Athletics, Grades 7-12

(3) Political Science
(4) Elective
(5) Elective
(6) **H.&P.E. 325a.-326b.** Laboratory

Fourth Year

(1) **H.&P.E. 320a.** Tests and Measurements and Adaptive Physical Education and **H.&P.E. 321b.** Physiology of Muscular Activity
(2) **H.&P.E. 400a.** Organization and Administration of Health and Physical Education, Grades 7-12, and **H.&P.E. 410b.** Methods, Materials, and Curriculum Construction in Health Education, Grades 7-12
(3) Elective
(4) Elective
(5) Elective
(6) **H.&P.E. 425a.-426b.** Laboratory

Students planning to enter educational work should consult the teacher-training adviser of the department. Certification in Texas at the secondary level may be obtained by certain required courses in Education and the student's chosen teaching field in the third and fourth years.

Reserve Officers' Training Corps Programs

Rice University offers two Reserve Officers' Training Corps programs—the Army and the Navy. The mission of these programs is to train college students so that they may qualify upon graduation as commissioned officers in a component of the United States Army or Navy. Upon successful completion of one of the R.O.T.C. programs and graduation with a baccalaureate degree, the student may be given a commission in the appropriate service. The Navy has two categories of midshipmen, one working toward a reserve commission and the other toward a regular commission. The Army normally awards reserve commissions; however, certain selected distinguished military students may be offered commissions in the Regular Army.

Any student suspended by the University for academic failure or other cause is immediately disenrolled from the R.O.T.C. programs. Any student performing unsatisfactory work in military or naval science courses, or possessing unsatisfactory officerlike qualities may be disenrolled from R.O.T.C. programs regardless of the quality of his academic work. Enrollment in the R.O.T.C. programs at Rice University is made at the beginning of the fall term only.

Military Science

The Department of Military Science was established in the fall of 1951. A U. S. Army officer, designated the Professor of Military Science, with assistance of officers and men of the U. S. Army, administers the program. Training in military leadership is emphasized, with instruction being given in subjects common to all branches of the Army. The Army R.O.T.C. course consists of two main subdivisions: (1) Basic and (2) Advanced. Students electing the Army R.O.T.C. program first elect the Basic Course, which may be completed by either of two methods: on campus during the Freshman and Sophomore years or off campus at a six-week summer camp between the Sophomore and Junior years. Upon completion of the Basic Course by either of these methods, the student, if recommended for further training, may elect the Advanced Course. All on-campus courses include one hour of drill per week.

In the on-campus Basic Course, Freshmen attend class one hour per week and Sophomores two hours per week.

The Advanced Course includes three classroom hours per week during the Junior and Senior years in management and command responsibilities and a six-week summer camp, normally between the Junior and Senior years, in practical military instruction.

A flight training program including thirty-five hours of ground instruction and thirty-six hours of flight instruction is available to physically qualified Army R.O.T.C. students during the second year of their Advanced Course. All textbooks, flight clothing, and equipment required for the program are provided at no cost to the student.

Four-year Army R.O.T.C. scholarships are available for award on a nationwide competitive basis to students who plan to take the Basic Course on campus, and two-year scholarships are available to Advanced Course students who have completed the Basic Course on campus.

Each scholarship student receives retainer pay of $50.00 per month with all tuition fees, books, and equipment paid for by the Army for the period of his scholarship. Nonscholarship students receive $40.00 per month during the two years of the Advanced Course.

Graduates of this program are commissioned in the various branches of the Army based upon the preference of the individual, his academic major, and his demonstrated leadership and technical qualification.

Naval Science

The Department of Naval Science at Rice University was established in the fall of 1941 and is an integral part of the organization of the University. It is administered by a senior U. S. naval officer who is the Professor of Naval Science. He is assisted by officers and men of the U. S. Navy and Marine Corps. The purpose of the Naval Reserve Officers' Training Corps is to train highly select young men for either naval service as commissioned officers of the Regular Navy and Marine Corps (Regular Program) or as reserve officers.

Students taking five-year courses are considered eligible for enrollment at the beginning of their first or second year. In view of the heavy academic loads for fifth-year engineering students and scheduling difficulties, all students are encouraged to enroll in the regular manner during Freshman matriculation.

There are two categories of N.R.O.T.C. students: (1) Regular; (2) Contract.

Regular Students. A regular N.R.O.T.C. student is appointed a Midshipman, U. S. Naval Reserve, on a nationwide competitive basis and receives retainer pay at the rate of $50.00 per month for a maximum of four years, with all tuition, fees, books, and equipment paid for by the government. Required uniforms are furnished. He is re-

quired to complete twenty-four semester hours for naval science subjects (one course per term, including those courses taught by the civilian faculty which are a part of the Navy curricula) and other training prescribed during the summer months, and upon graduation with a baccalaureate degree to accept a commission as Ensign in the U. S. Navy or Second Lieutenant in the U. S. Marine Corps.

Contract Students. Contract students are civilian college students who enter into a mutual contract with the Secretary of the Navy in which they obligate themselves to take naval science courses and drills and one summer training cruise. They must also agree to enlist in the Naval or Marine Reserve prior to starting the third year of Naval Science. Enlisted time during Junior and Senior years does not count in computing length of service. Should the student be dropped from the program through no fault of his own, he will be discharged from the Naval Reserve if he so desires. In return, the Navy provides the required uniforms, pays retainer pay at the rate of not less than $50.00 per month during the Junior and Senior years, and offers a reserve commission in the Navy or Marine Corps upon graduation.

Contract students are *not* selected by the competitive procedure indicated above for Regular students; rather they are selected by the Commanding Officer (Professor of Naval Science) from among those students who apply who are either selected for admission by Rice University or who are already in attendance.

U. S. Marine Corps. N.R.O.T.C. students, either Regular or Contract, may apply for transfer to the Marine Corps program during the Sophomore year. Such selectees are referred to as Marine Corps option students and attend separate classes under a Marine officer instructor during their Junior and Senior years.

The N.R.O.T.C. course of training consists of courses of instruction, laboratory periods, and drill, together with such training duty or training cruises as may be prescribed. One of several appropriate courses offered by the Department of Psychology is substituted for one semester of Naval Service.

The Navy prescribes certain course requirements for N.R.O.T.C. students as follows:

1. By the end of the Sophomore year each Regular student must have satisfactorily completed one year each of college physics and mathematics.
2. Every student must achieve proficiency in written and oral expression.

Rice University will prescribe standards of proficiency and determine procedures necessary to achieve them.

Academic Regulations

All students seeking a bachelor's degree are subject to the academic regulations of the faculty. The Committee on Examinations and Standing administers the rules described below. Under unusual circumstances any student may submit a written petition to the committee requesting special consideration.

Registration

All currently enrolled students register in May for the following academic year except for payment of fees. A student who does not file a course list, or request a delay by the deadline established by the Registrar will be considered withdrawn from the University by default. To be readmitted for the following fall term he must pay a $25 reinstatement fee. Entering students are sent preliminary registration materials during the summer, but course registration is completed during Freshman Week. All tuition and fees must be paid by August 26, except where a special tuition plan has been elected.

The course registration card of each student must be approved and signed by an adviser. Registrations of Freshman and Sophomore students are approved by faculty advisers appointed in the colleges; others are approved by an adviser appointed by the chairman of the department of the student's major field of study.

No student can be registered in or allowed to enter any course or section later than two weeks after the date of opening of courses as given in the Academic Calendar (page v). A student who makes a change of course or section after the first week of classes of a term is charged a fee of $10.00 per course. This fee is not charged when a change in student's registration is a result of modification of the course offerings or class schedules of the University.

Course Programs

A student at Rice is normally expected to enroll in five courses each semester and thus, in eight semesters to have completed the forty courses required for graduation. During any four semesters, a student may request the approval of his advisor for dropping one course at any time up to the end of the tenth week of the semester and, thereby, reduce his course load to four for that semester. That course will be recorded as dropped on his transcript. Extension of the option to drop courses beyond these four semesters is possible in

unusual circumstances, e.g., poor health, by special permission of the Committee on Examinations and Standing.

When using this option to drop courses, the student must recognize that he still has to take the course, or an acceptable alternate to fulfill the degree requirements, and thus, he should make definite plans to make up the credit either in summer school or in a subsequent semester. By dropping four courses and not making them up, a student will delay his graduation by at least one semester.

A student failing to complete a first baccalaureate degree within four full years is permitted to register for only those courses actually needed for graduation, provided he is not on probation. His tuition will be determined as specified on page 77.

Approval of Majors

In the second semester of the Sophomore year, each student is required to submit his choice of major to the Committee on Examinations and Standing. The committee's action is guided by (1) aptitude shown by the student's record during the first two years; (2) limitations of departmental capacities for receiving students in the various major programs. Until a student's major has been approved he cannot enter the Junior courses of that curriculum.

Change of Curriculum

Any proposed change of curriculum is subject to the approval of the Committee on Examinations and Standing. At its discretion, the committee may require any student to change his curriculum when his work is unsatisfactory.

Examinations

Written three-hour examinations are given in all undergraduate courses at the close of each semester. Late semester examinations are given only when an examination is missed because of illness or some other unavoidable circumstance, and only on approval of the Committee on Examinations and Standing.

Other tests are given from time to time at periods decided by the instructors. All tests and examinations are conducted under a student honor system (*see* p. 91). In determining grades, instructors consider both performance during the term and the record of examinations.

Grade Symbols

Grade symbols have the following meanings: 1—Very high standing; 2—High standing; 3—Satisfactory standing; 4—Poor standing; 5—Failure. Many courses require two consecutive semesters for com-

pletion. A student who fails the first semester of a two-semester sequence will not be permitted to continue in the second semester, except with the written recommendation of the course instructor. Grades are recorded for the first semester in January and for the second semester in May.

Grades of "Incomplete" are reported to the Registrar when a student does not complete a course because of illness or other circumstances beyond the student's control. The course must be completed and a numerical grade reported by the end of the twelfth week of the next semester. Otherwise the grade is recorded as "5".

President's Honor Roll

Outstanding students are honored each semester through the publication of the President's Honor Roll, which includes all students who have no grade less than 2 in any course, and also those students who have made no grade below 3 and have earned twice as many grades of 1 as of 3. This distinction is made a part of the student's permanent record. A student who carries a reduced schedule is not eligible for the President's Honor Roll.

Probation

A student who fails to do academic work of high quality is placed on probation by the Committee on Examinations and Standing if:

(1) he does not earn passing grades in at least 75 per cent of his approved schedule in any semester.
(2) he does not earn grades of 3 or higher in at least 50 per cent of his course program in any semester.

The period of probation extends to the end of the next semester in which the student is enrolled in the University. A student is not placed on probation more than twice during his residence, but instead of a third probation is placed on academic suspension.

A student who goes on probation at the end of the year in which he is a degree candidate but who is eligible to reregister may complete his degree requirements by earning grades, in a program of at least four additional courses, that remove him from probation.

A student on probation, either academic or disciplinary, is not permitted to be a candidate for or to hold any elective or appointive office or honor, or to serve as editor, assistant editor, business manager, or assistant business manager of any University publication.

Academic Suspension

Any student whose academic standing is unsatisfactory may be suspended from the University. A student's standing is considered unsatisfactory:

(1) at any time he is failing in one-half or more of the work in which he is enrolled. This clause does not apply to an undergraduate student at the end of his first semester at the University.
(2) when, after having been placed on probation twice he fails to maintain passing grades in at least 75 per cent and grades of 3 or higher in at least 50 per cent of the semester hours in which he is enrolled.
(3) if he fails to assume his responsibilities as a student as evidenced by excessive absence from classes or laboratory sessions or continued failure to perform required assignments.

A student who has been suspended may re-enter at the beginning of the next semester following one year's absence from the University, unless the Committee on Examinations and Standing stipulates a different period of suspension. When a different period is under consideration, the committee will request reports and recommendations from the members of the faculty acquainted with the student and his work and the appropriate College Master. In some instances, suspension may be permanent.

Special Probation

At its discretion, the Committee on Examinations and Standing may grant the privilege of special probation to an individual student who otherwise would not be permitted to continue at Rice University in his desired program. Special probation requires that a student shall have no grade less than 3 during the period of his special probation and, further, that he must remain off probation thereafter.

Voluntary Withdrawal and Readmission

A student who withdraws voluntarily while not on probation will ordinarily be readmitted within three years. Any student desiring to withdraw voluntarily from the University must do so in person or by letter at the office of the Dean of Undergraduate Affairs to be eligible for readmission. If withdrawal occurs within five weeks of the beginning of any semester examination period, grades as of the date of withdrawal may be used to determine eligibility for readmission.

Removal of Course Deficiencies

Course deficiencies resulting from failing grades, changes in curriculum or an approved reduction of course schedule may be removed by satisfactory work in summer school. To obtain credit for summer school work, prior approval of the Committee on Examinations and Standing for specific courses must be obtained, and a transcript showing the student has satisfied all conditions stipulated by the committee must be submitted. Credit is not given for more than four sum-

mer school courses taken to remove deficiencies, nor is credit for future courses in a student's program granted for work done in summer school.

Graduation

To be recommended for any bachelor's degree, a student must have earned grades of 3 or better in at least 50 per cent of work prescribed for that degree, including grades of 3 or better in at least 50 per cent of work undertaken in his major field after completion of the Sophomore year. He must not go on probation at the end of the year in which he is a degree candidate.

Honors

The Committee on Examinations and Standing reviews each student's record at the time of graduation and recommends to the faculty outstanding students to be granted degrees *cum laude, magna cum laude,* or *summa cum laude.*

Admission of New Students

In selecting members of the Freshman class from the large number of well-qualified candidates who apply for admission, Rice University undertakes to identify and to admit, irrespective of race or creed, those with exceptional ability and potential who appear best prepared to grow toward intellectual maturity.

The criteria used in the prediction of such development are of three basic types: 1) scholastic record as reflected by courses chosen and the quality of performance; 2) scores made on the Scholastic Aptitude and Achievement Tests administered by the College Entrance Examination Board; and 3) evaluations made by teachers, counselors, and interviewers. Scholastic performance provides a reasonable indication of the applicant's study habits and self-discipline. College Entrance Examination Board scores furnish a credible basis to compare one individual with a very large number of other persons of similar background (when set to a specific scholastic assignment). Interview reports and ratings obtained from high school teachers and counselors give some insight into extracurricular areas of development and such currently unmeasurable factors as motivation, intellectual curiosity, and emotional stability, which must also be considered.

The experience of Rice University indicates that those most likely to succeed are the applicants who have, in addition to the obvious desirable personal traits, high scholastic standing and high College Entrance Examination Board scores. Not all students with superior scholastic standing and comparable College Entrance Examination Board scores become outstanding Rice students; however, nearly all well-adjusted, well-motivated students of high intellectual capacity and intellectual curiosity have good chances of success.

Students are selected on a competitive basis in accordance with admission quotas in the (1) Architecture, (2) Humanities and Social Sciences, and (3) Science-Engineering programs of the University. New students enter only in September of each year.

1. The High School Record. The completion of not less than sixteen acceptable units is required. The record must include the following units:

English	4	Laboratory science (Biology, chemistry, physics, etc.)	2
Social studies	2		
Algebra	2		
Plane geometry	1		
Trigonometry	½	Additional credits in above-listed solid subjects	2½
A foreign language	2		
		Total	16

Both physics and chemistry are required of applicants for the Science-Engineering Division. A course in high school chemistry is prerequisite to the first-year course in chemistry.

2. Entrance Examinations. The required entrance examinations are administered by the College Entrance Examination Board. Formal arrangement for applying to take the C.E.E.B. examinations, as well as for paying fees, is a matter between the applicant and the College Entrance Examination Board. The bulletins are available on the Rice campus, for those who find it convenient to call for them, and from high school counselors.

The following examinations are required according to the curriculum involved:

Academic and Architecture

(1) Scholastic Aptitude Test
(2) Three Achievement Tests as follows:
  (a) English composition
  (b) Any two of the following:
    A foreign language
    American History and Social Studies
    European History and World Affairs
    Mathematics
    A science

Science-Engineering

(1) Scholastic Aptitude Test
(2) Three Achievement Tests as follows:
  (a) English composition
  (b) Mathematics (Level I or Level II)
  (c) Chemistry or physics

(3) For Architecture candidates only: Architectural School Aptitude Test

A list of the courses of study and majors offered may be found on pages 53-62.

3. Personal Interviews. Interviews are an integral part of the admission procedure. They enable the Admissions Committee to reach a decision based on nonacademic, as well as academic, aspects of the candidate's development. The candidate should arrange for an interview before the closing date for applications. Campus interviews will be held at 109 Lovett Hall between the hours of 9 A.M. and 4 P.M., Monday through Friday, and until 11:30 on Saturday mornings. (Summer schedule: Monday through Friday, 9:00 A.M. to 4:00 P.M.) Applicants who cannot visit the University or who are unable to meet with a traveling member of the Admissions Committee may be interviewed by alumni interviewers located throughout the United States and in several foreign countries. If an applicant cannot be interviewed by one of these methods, the interview will be waived without prejudice.

4. Evaluations from High School Counselors and Teachers. Confi-

dential rating sheets submitted by the applicant's high school teachers and counselors are considered in connection with every application.

Early Decision Plan

The Early Decision Plan is designed for prospective candidates for admission who regard Rice University as their first choice and will await the outcome of the application to Rice before applying elsewhere. Early Decision applications will be available July 1 after the junior year in high school and must be filed by October 10 of the senior year. Therefore, the required College Entrance Examination Board tests must be taken no later than July following the junior year. The personal interview requirement may be satisfied at any time prior to the October 10 deadline. Early Decision applicants will be notified of the Admissions Committee's decisions by November 15.

Action on some candidates may be deferred until the Regular Decision period in April if the Admissions Committee does not have adequate grounds for an affirmative decision in November. An additional semester of the high school record and additional C.E.E.B. scores from the December and January tests may be added for consideration in the spring. The applicant would, of course, be released from his pledge to apply only to Rice.

Requirements for admission are not altered if a student applies for an early decision. Those accepted early will be expected to complete the remainder of their high school work with the same superior performance.

A non-refundable deposit of $100 is required by December 1 if admission is granted in November. An additional deposit of $50 must be made before March 1 by one who wishes to reserve a room in one of the residential colleges. These deposits are not covered by any financial aid that Rice offers.

An Early Decision candidate who wishes to apply for financial assistance must file the Parents' Confidential Statement by October 1. Offers of financial assistance and notices of admission are sent simultaneously in November. (For further details see page 74.)

Regular Decision Plan

The Regular Decision Plan is designed primarily for candidates who did not take C.E.E.B. examinations during the junior year or those who have more than one college under consideration. The Regular Decision candidate may wait as late as December or January to complete his C.E.E.B. tests and to file applications for admission and financial aid. Interviews should be completed by February.

Regular Decision candidates are notified of the Admissions Committee's decisions during the first week of April. The candidates who are offered admission must respond with a $50 registration deposit by

May 1 to reserve their place in the incoming class. Those who wish to reserve a room on campus must make an additional $50 deposit when notified of room assignments.

Admissions Schedule
(Early Decision and Regular Decision)

	Early Decision	*Regular Decision*
C.E.E.B. Examinations Deadline	July	January
*Application Forms Available	July 1	October 15
Filing Deadline	October 10	February 1
Financial Aid:		
PCS Available	September 1	September 1
Filing Deadline	October 1	February 1
Interview Deadline	October 10	February 1
Notification Date	November 15	Early April
Candidates Reply Date (with registration deposit)	December 1	May 1
**Room Deposit	March 1	When Notified

* No application fee is required of candidates for admission to Rice.
** Room application forms and detailed information concerning residence in the colleges will be sent when admission is granted.

Financial Assistance Available to New Students

Rice University recognizes its continuing responsibility to provide the highest quality instruction for a limited number of exceptional students. To this end the University provides a program of financial assistance based on the applicant's need in order that no qualified student will be denied admission because of an inability to pay tuition. The program combines the use of grants with loan funds in an attempt to provide students with sufficient aid to meet educational expenses beyond the resources of the student and his parents.

It must be realized, however, that financing higher education is primarily the responsibility of the student and parent and, since available University grants and loan funds are limited, each applicant is urged to take advantage of any opportunity to seek other scholarship aid.

Regular decision applicants for financial aid must file the Parents' Confidential Statement with the College Scholarship Service before February 1.

The Parents' Confidential Statement forms for regular decision may be obtained from high school counselors or directly from the College Scholarship Service, Box 176, Princeton, New Jersey 08540.

Candidates applying for admission under the Early Decision Plan must obtain the Parents' Confidential Statement forms from the Office of Admissions or the Financial Aid Office at Rice and must file them with the College Scholarship Service by October 1. Parents' Confidential Statement forms used by Early Decision Candidates must be those applicable to the academic year for which admission is being sought. If a prior year form is used it must be returned, thus causing a delay in notification.

Requests for additional information about financial assistance should be addressed to the Financial Aid Officer, Rice University, Houston, Texas 77001. The Parents' Confidential Statement constitutes an application for financial assistance. When Rice University receives it from the College Scholarship Service, the applicant is then considered for all appropriate grants or scholarships administered by the University. No other application is needed.

Notifications of offers of financial aid accompany notices of admission to Rice. Financial aid grants or scholarships made on an annual basis are payable one-half each semester.

Advanced Placement

Entering freshman who have done work well beyond the usual high school courses in certain subjects and who make superior scores on the Advanced Placement examinations offered by the Educational Testing Service will be given recognition for their achievements. Degree credit and advanced standing may be given in the following subject-matter fields: biology, English, French, German, history, physics, and Spanish. Students who make superior scores on the examination in chemistry may earn degree credit in chemistry by completing certain required laboratory work in quantitative analysis during their Freshman year.

Departmental placement examinations in mathematics and foreign languages are given on the campus in the fall. A satisfactory grade permits the student to enroll in Mathematics 220 but does not give him credit for Mathematics 100. Grades in the foreign language examinations are used to determine the student's placement in a language which he has studied in high school and wishes to continue.

Transfer Students

Admission to Rice is possible for students with superior records at another college. In order to be considered for admission as a transfer student, the applicant must have completed a minimum of ten semester-length courses which are applicable to the degree he will seek at Rice. All new students enroll only in September of each year. A minimum of two years in residence is required for a Rice degree.

A candidate should file the Preliminary Application between Feb-

ruary 1 and April 1. When requesting the proper forms, the applicant should indicate clearly the number of years he will have completed in his present college by the following September. If the transfer applicant has never taken C.E.E.B. tests, he should take the Scholastic Aptitude Test in December, January, or March.

Transfer applicants seeking financial assistance should file the Parents' Confidential Statement with the College Scholarship Service.

Decisions regarding transfer applications are usually made during May.

For further information or application forms, prospective candidates for admission as undergraduates should communicate with the Director of Admissions. When requesting application forms, the candidate should clearly indicate whether he is a prospective high school graduate or a prospective transfer from another college.

Student Housing

A prospective student should indicate on his application for admission whether or not, if admitted as a student, he desires to reside on the campus. Detailed information about residence in the colleges and room application forms will accompany the notice of admission sent to each new undergraduate. To reserve rooms it is essential that applications be submitted as directed. New undergraduate women students who do not live with their families in metropolitan Houston are required to live in one of the women's colleges.

Correspondence from new students regarding housing in the residential colleges should be addressed to the Office of Admissions.

Tuition, Fees, and Expenses

The tuition and fees charged to undergraduate students who entered in September, 1967 are as set forth below. These charges are subject to change from time to time as the operating expenses of the University increase. It is not anticipated, however, that any major change will be required for 1968-69.

Tuition

The tuition for all undergraduate students who entered Rice University in September, 1967, is $1,500 per year, payable $750 at the beginning of each semester.

A student who has not completed the requirements for his bachelor's degree after four full years of study (or after five years if a candidate for a five-year bachelor's degree) will be charged full tuition unless a reduced tuition rate has been specifically approved for him as the result of a petition submitted to the Committee on Financial Aid. The reduced rate is $60.00 per semester hour in which the student is registered, up to but not exceeding the full tuition charge of $750 each semester.

An undergraduate who withdraws from the University and returns at a later date will be charged the same tuition as is being paid by the members of the class he enters upon his return.

Fees

Students who entered in 1967 were charged the following annual fees. These fees are paid at the beginning of the term in the fall.

Subsidies to students' activities	$11.50
Tickets to athletic events	4.00
College fee	15.00
Health Service	12.00
Total fees charged to new undergraduate students	$42.50

In addition, each student paid a laboratory fee of $10.00 per semester for each of the laboratory courses in which he registered.

Special Charges

Freshman Week	$20.00
Late Registration	15.00
Late Change of Registration, each course	10.00
Diploma	6.00
Army R.O.T.C.	10.00

Guaranty Bond

Every undergraduate student regardless of age is required to provide a $300.00 guaranty signed by himself and a parent, guardian, or other responsible adult, excluding a spouse or another student.

Refund of Tuition

If a student withdraws from the University before the beginning of the second week of classes, 90 per cent of the tuition paid will be reduced by 10 per cent of the total tuition charge each week that the student remains enrolled. There is no refund of fees or special charges after a student once attends classes.

Student Teaching Internship Fees

Regular students who have just completed a bachelor's degree and go immediately into the summer program and internship will be required to pay only the present course fee of $62.50 each summer or term of internship until the summer of 1969. After that such students will be charged tuition at a rate to be determined in relation to the costs of the summer program.

Former students admitted for the purpose of completing teacher certification will pay the $50 registration fee in addition to the course fee of $62.50 each summer until the summer of 1969, after which they will pay the established tuition rate and registration fee.

Delinquent Accounts

No student in arrears in any financial obligation to Rice University as of the date announced for the completion of registration for any semester will be registered. No certificate of attendance, diploma or transcript of credit will be issued at any time for a student whose account is in arrears.

Students who have not made satisfactory arrangements with the Cashier for payment of current charges, and those living on campus who have not executed a satisfactory room contract, by the end of the second week of classes in any semester may be dropped from the rolls of the University.

Transcripts

Transcripts are issued on requests made to the Office of the Registrar. No transcript is issued without consent of the individual whose record is concerned. Each student is entitled to two free transcripts. There is a charge of $1.00 for each additional copy, payable in ad-

vance. Those requesting transcripts by mail should include payment with the request.

Living Expenses

Residence fees to cover costs of dining halls, operation of residences, and the Health Service are established from year to year as requirements dictate. For 1967-68 the yearly fee for residence in the men's colleges was $1,029, in the women's college $1,112. This charge provides for room and three meals per day excluding the evening meals on Saturdays and Sundays. Meals are not served during the Thanksgiving, Christmas, mid-term, and Easter recesses. The women's colleges are closed to all residents during the two-week Christmas recess. When securing room assignments for the academic year to follow each student is required to make a room deposit of $50. To assure reservation of space current students must make room deposits by the date established in the various colleges, but no later than April 1. New students are required to make a similar deposit upon notification of room assignments during the summer. These deposits are returnable only upon individual application and for good and sufficient cause. The balance of the residence fee is payable in two approximately equal installments. The exact amounts and due dates are stated in the Residential College Agreement which each resident is required to sign.

All items included, the young man or woman entering Rice University in September,1968, who will live on campus will need to have available about $3,350 for the first year. For a student living at home the cost will be about $2,600.

Scholarships and Financial Aid

Undergraduate Scholarships and Grants

To encourage students in devotion to learning and in striving to develop creative capacity in productive scholarship many friends of Rice University have established undergraduate scholarships and grants-in-aid. These are reserved principally for students who have been in residence at least one year, although a few are designated for entering Freshmen with exceptional records. Honorary scholarships without stipend are also awarded to students who have demonstrated outstanding ability and promise of future development.

The Board of Governors has established a program of tuition grants extensive enough to assure that no student will be denied admission because of inability to pay tuition. The total amount of these grants is the equivalent of 175 four-year, full-tuition awards and 75 four-year, partial-tuition awards. In addition, a number of Arthur B. Cohn Prize Scholarships are awarded to entering Freshmen with excpetional records, without regard to financial need of the recipients.

John McKnitt Alexander Chapter of the Daughters of the American Revolution Scholarship. An endowed undergraduate scholarship for a young woman student of Rice University.

American Institute of Chemical Engineers, South Texas Section. Provides a scholarship for a student of chemical engineering who is a resident of the area served by the Section.

Amyx Memorial Scholarship. Established in 1964 by the Gulf Coast Section, Society of Petroleum Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., as a memorial to James W. Amyx. Awarded annually to a Sophomore in an engineering program related to the mineral industry.

Achievement Rewards for College Scientists Foundation Scholarships. Established by the Houston chapter in 1965 to assist students of science and technology who excel in these fields and who need monetary assistance to pursue their educations.

Samuel S. Asche Scholarship. Awarded annually to the student having highest standing at the end of the Freshman year.

Associated General Contractors of America Scholarships. Established by the Houston chapter in 1965 to assist students in civil engineer-

ing and awarded on the basis of scholarship and promise for future professional achievement.

Max Autrey Memorial Scholarships. Established under the will of the late Mrs. Nettie S. Autrey in memory of her son. First awarded in 1942, they are open annually to all current students.

Axson Club's Axson Wilson Scholarship. Established in 1922 in memory of Mrs. Woodrow Wilson for a young woman student of Junior or Senior standing.

Axson Club Katie B. Howard Scholarship. For young women of Junior or Senior standing, in memory of Mrs. A. R. Howard; has been awarded annually since 1937.

Graham Baker Studentship. The first undergraduate scholarship established at the Rice Institute. It is awarded annually to the student in the three lower classes earning the highest scholastic standing for the academic year.

James A. and Alice Graham Baker Distinguished Scholarship. Established by the will of James A. Baker in 1941 to encourage and assist needy and worthy students.

R. C. Baker Foundation Scholarships. Four scholarships in mechanical engineering honoring the founder of Baker Oil Tools, Inc.

Mr. and Mrs. Val T. Billups Scholarship. Established by the named donors in 1953 for students of engineering above Freshman standing.

Borden Freshman Prize. Given to the student having the highest grades for all work of the Freshman year.

Brochstein Foundation Scholarships. Established in 1965 to assist and encourage worthy undergraduate students.

Brown College Scholarship. Made available by the Margarett Root Brown College Cabinet for a member of the college who has maintained high academic standing and has contributed significantly to the college life.

Clyde and Ethel Butcher Scholarship. Established by the named donors in 1967 to assist needy and worthy students.

Chapman-Bryan Memorial Scholarship. Created in 1937 by the bequest of Miss Johnelle Bryan on behalf of her sister, Mrs. Bryan Chapman, and the donor.

The Arthur B. Cohn Prize Scholarships. Established in 1967 to honor Mr. Cohn who served for many years as Assistant Secretary to the Board of Trustees. These scholarships are awarded on a merit basis, without regard for financial need, to very exceptional students of the entering Freshman class.

College Bowl Champions Scholarship. Established from funds awarded for successful competition in the College Bowl in 1966.

College Women's Club Scholarship. Established in 1942 to provide a scholarship to assist a young lady in her first year of graduate study. The scholarship is awarded annually to a graduating Senior.

Continental Air Lines Foundation Scholarship. Established in 1964 to assist and encourage a worthy undergraduate student.

Continental Oil Company Scholarship. Awarded to a student with high standing in chemical engineering.

Millie Tutt Cook Scholarship. For the benefit of a Junior or Senior student preparing for a career in teaching.

Thomas A. and Pauline M. Dickson Scholarships. Established in 1932 to assist young men and women students who are largely self-supporting.

E.B.L.S.-E.B.L.S. Alumnæ Scholarship. Established in 1926 to assist a young woman student of the University.

Engineering Alumni Scholarship. Awarded to a student who is a candidate for a Bachelor of Science degree in one of the four branches of engineering.

Ray C. Fish Foundation Scholarships. Established in 1965 to aid and encourage a deserving young man and young woman of the entering class.

Thomas Flaxman Scholarship. Established in 1962 by Mr. Thomas Flaxman in honor of Dr. Lindsay Blayney to assist in providing educational opportunities for deserving students.

Walter W. Fondren, Jr., Memorial Scholarship. Established in 1961 by Mr. and Mrs. W. B. Trammell in memory of Walter W. Fondren, Jr., to assist men or women students.

Thomas R. and Julia H. Franklin Scholarships. Established in 1937 for annual scholarships to well-qualified, necessitous students.

General Motors Scholarship. A scholarship for an entering Freshman, renewable through four years contingent on satisfactory work. Awarded in alternate years.

Gibraltar Savings Association Scholarship. Established in 1959 for a male member of the entering Freshman class whose intention is to concentrate in the field of economics or business administration.

Mary Parker Gieseke Scholarship. Awarded annually to a student who has been in residence at least one year.

Blanche Randall Haden Scholarship. Awarded annually to a deserving undergraduate specializing in economics.

William D. and Lucy L. Haden Travel fund. Founded by Mr. Cecil R. Haden for the purpose of providing an opportunity for sophomore architecture students to make a class field trip to visit various areas of the United States.

Haskins and Sells Foundation Scholarship in Accounting. Awarded to a Senior student having high academic standing in accounting, and planning to enter the fifth year of the accounting program.

William Clifford Hogg Fund. Established by the will of William Clifford Hogg in 1936. From this fund two scholarships are awarded annually, the *Will Hogg Memorial Distinguished Studentship* and the *Will Hogg Memorial Scholarship.*

Hohenthal Scholarships. Awarded to students of high scholastic standing who are earning a substantial part of their expenses.

Houston Engineering and Scientific Society Scholarship. Awarded to a Senior or fifth-year engineering student who is recommended to the Society by a committee of the University faculty.

William V. Houston Scholarship. An award to an incoming male Freshman student established in 1961 by Dr. George Robert Kolodny.

M. M. Feld and J. P. Hamblen Interfaith Charity Scholarship. Provided by the Interfaith Charity Bowl, Inc., to assist a student active in interfaith pursuits.

Louis F. Israel Premedical Scholarship. Donated by Dr. Israel in 1962 to assist a needy and worthy premedical student.

Jefferson Chemical Company, Inc., Scholarship. Established in 1967, there are two scholarships awarded to students above the Sophomore level, one in Chemistry and one in Chemical Engineering.

Joint Organization for Business Survival Scholarships. Established in 1965 to assist students in the general area of marine biology and oceanography.

Jones College Scholarship. Made available by the Mary Gibbs Jones College Cabinet for a member of the college who has maintained high academic standing and has contributed significantly to the college life.

Jesse H. Jones Naval Scholarships. Given in honor of Fleet Admiral William F. Halsey, Jr., and General Alexander Archer Vandegrift.

All members of the N.R.O.T.C. unit, including entering students are eligible.

Grant William Jordan and Cora Jordan Memorial Fund. Available in trust to assist young men and women in obtaining an education at Rice University.

Louise S. Koehler Scholarship. Established in 1965 by the will of Louise S. Koehler for the assistance of young women in securing an education at Rice University.

Lady Washington Texas Centennial Award. Made annually to a young woman student from funds donated by the Lady Washington Chapter of the Daughters of the American Revolution.

Patrons of E. L. Lester and Company Scholarship. An annual award provided by E. L. Lester and Company in honor of its employees and customers, for an entering male student in engineerig, physical science, or related fields.

M. David Lowe's Personnel Services, Inc., Scholarship. Awarded to a student majoring in the Behavioral Sciences.

Lubrizol Scholarship. Provided by the Lubrizol Foundation for a third-, fourth-, or fifth-year student in chemical engineering.

Margaret Brokaw McCann Scholarship. Established by her husband the late S. G. McCann, first Rice Registrar, by their son, Dr. S. M. (Donald) McCann, and by many friends, it is awarded to a high-ranking, deserving young woman of one of the three upper classes, who plans advanced work in nursing, medicine, or other welfare fields. It was first awarded for the 1963-64 academic year.

John T. McCants Prize in Accounting. Established by friends in 1965 in honor of the late Mr. John T. McCants, first Bursar of Rice University. Awarded to a deserving Senior planning to enter the fifth year of the accounting program.

Emma S. McGree Scholarships. Established by the will of Mrs. Emma S. McGree in 1964 in honor of Miss Katie Scherffius and Mr. John T. Scherffius; for entering Freshmen men and women.

T. S. Martino Scholarship. The will of T. S. (Tony) Martino, long-time head gardener of the campus, bequeathed a generous fund which will provide scholarship assistance for undergraduate students.

Leonard S. Mewhinney Scholarship. Established in 1952 by the Brown Foundation, is awarded to a Naval R.O.T.C. engineering student enrolled in his fifth year at Rice University who has attained high academic standing and demonstrated aptitude for the naval service.

Achille and Malline Meyer Memorial Scholarship. Awarded annually to a fully or partially self-sustained student of the University.

Fannie Bess Emery Montgomery Scholarship. Established in 1963 by the John McKnitt Alexander Chapter of the Daughters of the American Revolution to assist a worthy young woman.

Ida R. and Hanna E. Nussbaum Scholarship. Provides an undergraduate scholarship in memory of the late Miss Ida R. Nussbaum and her sister.

Rebecca Raphael and Lilly G. Nussbaum Scholarship. Established under the will of the late Miss Ida R. Nussbaum in memory of her mother and sister.

Charles Breckenridge Parkhill Scholarship in Political Science. An endowed scholarship established by J. M. Lykes, Jr., in honor and memory of his grandfather, to be awarded annually to a worthy upperclassman majoring in political science.

Price Waterhouse Foundation Scholarship. Awarded to fifth-year Accounting students.

Procter and Gamble Scholarships. A four-year scholarship established by the Procter and Gamble Company for one or more entering Freshmen who plan to study in the field of engineering or science. The first award was made in the fall of 1963.

Emanuel and Mose Raphael Scholarship. Established by bequest of Miss Ida R. Nussbaum in memory of her uncles.

William Marsh Rice Tuition Grants. Established by the Board of Governors of Rice University in 1965 to provide assistance to students from Texas having financial need.

Richardson Fund. Bequeathed in trust by Mrs. Libbie A. Richardson, widow of Alfred S. Richardson, who was a charter member of the Board of Trustees of Rice University.

Daniel Ripley Scholarship. Established in 1927 by the late Mrs. Edith Ripley in memory of her husband. Awarded to a self-supporting young man or woman completing the Freshman year with outstanding scholarship.

Edith Ripley Scholarships. Established in 1928 by the late Mrs. Edith Ripley to be awarded annually to three young women students.

James M. and Sarah Wade Rockwell Scholarships. Established by a fund donated in 1958 in memory of the founders of the Rockwell Fund, Inc.

Catherine Withers Roper and Benjamin E. Roper Memorial Scholarships. Established through the will of their daughter, Miss Mary Withers Roper, to assist worthy students of the University.

Schlumberger Collegiate Award. Given by the Schlumberger Foundation for an advanced student with high standing in physics, geology, or electrical or mechanical engineering.

Sara Stratford Scholarship. For women students of Rice University commemorating the late Mrs. Sara Stratford, first Adviser to Women.

Terra Club Scholarship. Awarded to an undergraduate or graduate geology student.

Texaco Scholaships. Made possible by Texaco, Inc. Awaded to Junior and Senior students of proven scholastic ability who have demonstrated qualities of leadership.

H. Platt Thompson Scholarship. Established in 1965 to assist a male student from the state of Texas who is enrolled in Civil Engineering.

University Tuition Grants. Established by the Board of Governors of Rice University in 1965 to assist students having financial need, regardless of residence.

University Women's Alliance Scholarship. Awarded to a Junior or Senior girl, preferably a resident of Texas who is in need of financial assistance.

Vulcan Materials Company Scholarship in Architecture. Established in 1956 for students in architecture above Sophomore standing. Awards are made annually during the first semester.

John B. Warren, Jr., Scholarship. Established in 1966 to be awarded to a worthy male Pre-Law or Mechanical Engineering student.

Abe and Rae Weingarten Scholarships. Established by the named donors in 1963 to assist needy and qualified students to continue their education.

Harris Weingarten Scholarship. Established by Abe and Joe Weingarten in memory of their father. First awarded in 1957.

Western Electric Fund Scholarship. Maintained by the Western Electric Fund for a student in engineering who has demonstrated exceptional promise and ability in his chosen field.

Blanche White Honor Scholarships. Awarded solely on academic excellence to students earning exceptionally high scholastic standing.

Student Loans

Students who find themselves in need of financial assistance to help defray academic expenses, such as fees, books, and room and board charges, should address inquiries to the Financial Aid Officer, Lovett Hall. Several types of loan funds are administered by this office, in-

cluding the National Defense Student Loans and loans provided through the generosity of a number of friends of the University.

Karl Bailey-William Carroll Memorial Loan Fund. Established in 1956 by friends of Karl B. Bailey and William Carroll.

Frank McFadden Caldwell Loan Fund. Established in 1953 by Mr. and Mrs. L. C. Caldwell in memory of their son Frank McFadden Caldwell.

Louise Adele Drenkle Loan Fund. Established in 1965 by Mrs. Camille W. Brown in memory of Louise Adele Drenkle, widow of Colonel James Wood Nichols.

Mary Alice Elliott Loan Fund. Established in 1931 in memory of Mary Alice Elliott by her parents, Mr. and Mrs. Card G. Elliott. Awarded to a fifth-year student or alumnus of the Department of Architecture under thirty years of age for foreign travel and study.

Houston Bridge League Loan Fund. Established in 1962 by the Houston Bridge League.

Leo M. Levy Memorial Loan Fund. Established in 1947 by the Jewish Family Service.

Lora B. Peck Loan Fund. Established by the College Women's Club of Houston in 1951.

Rice University Students Loan Fund. Established in 1923 by a group of friends of the University.

Students Memorial Loan Fund. Established in 1936 by the will of William Clifford Hogg in memory of his father and mother.

Owen Wister Literary Society Alumnæ Loan Fund. Established in 1940 by the Owen Wister Literary Society Alumnæ.

Student Employment

It is strongly recommended that students in their first year do not plan part-time employment unless absolutely necessary to meet expenses. A college course of study is a full-time job requiring fifty to sixty hours per week to do justice to the educational opportunities presented through course work. In addition, every student should take advantage of the many other opportunities for growth and development that come through participation in the social, political, and cultural activities of the colleges and the student government. New students who must supplement their income are advised to consult the Financial Aid Officer.

There are on the campus and in the city opportunities in considerable variety for worthy and deserving students to earn a part of their expenses. Interested students should visit the Placement Office in the Memorial Center as early as possible.

Academic Honors and Awards

Honor Societies

The *Phi Beta Kappa Society.* The Senate of the United Chapters of Phi Beta Kappa at its meeting in December, 1927, voted to recommend the establishment of a chapter at the University and at a meeting of the National Council held in September, 1928, the institution of the Rice, or Beta of Texas, chapter was duly authorized. The chapter was formally installed on March 1, 1929, by the secretary of the United Chapters.

The *Society of the Sigma Xi,* for the promotion of research in science, on the occasion of its thirty-eighth annual convention in December, 1937, acting upon the recommendation of the Executive Committee, duly authorized the establishment of a chapter of the Society at the University. The formal installation of the Rice chapter by the president of the national organization took place on March 23, 1938.

The *Tau Beta Pi Association,* organized to interest engineering students in competing for high standing in scholarship authorized at its annual convention on October, 1940, the establishment of a chapter of the Association at the University. The Rice chapter, the Gamma of Texas, was formally installed on December 18, 1940, by the national secretary of the Association.

Delta Phi Alpha, German national honorary society, was founded to promote among university students an interest in the German language and literature. The National Council in April, 1949, authorized the organization of the Gamma Xi Chapter at Rice.

Phi Lambda Upsilon, an honorary chemical society, has as its purpose "the promotion of high scholarship and original investigation in all branches of pure and applied chemistry." The Alpha Alpha Chapter was installed at the University in 1927.

The *Pi Delta Phi Society,* organized to interest students of French in competing for high standing in scholarship, authorized in May, 1930, the formation of a chapter of the Society at Rice. The Theta Chapter was formally installed in that year by a delegate of the national organization.

Sigma Delta Pi, Spanish national honorary society, was founded to promote among university students an interest in the Spanish language and literature. The chapter at the University was installed on May 14, 1953.

The Alpha Zeta Chapter of *Sigma Tau,* an engineering society devoted to scholarship, practicality, and sociability, was installed at the University on May 20, 1953.

Tau Sigma Delta, a National Honor Society in Architecture and Applied Arts. The Tau Chapter was established at the University on May 7, 1961.

Prizes and Awards

Several prizes and awards are presented annually in recognition of accomplishment in various endeavors. They are made possible by individuals and organizations who wish to encourage students in certain activities and honor the name of a friend or a relative. These prizes constitute a signal honor to the recipient.

The *American Institute of Architects Award* is presented to a fifth-year architectural student on the basis of undergraduate scholastic achievement, character, and promise of professional ability.

The *American Institute of Architects Henry Adams Award* is granted to the alternate of the American Institute of Architects Award.

The *Alpha Rho Chi Medal* is awarded to a fifth-year architectural student on the basis of leadership, service, and sign of promise in the profession of architecture.

The *Hubert E. Bray Award* is presented to the outstanding Freshman student of Jones College.

The *James H. Chillman, Jr., Prize* is awarded annually by the Rice Architectural Alumni Association for the best pictorial or graphic presentation of a building during the year.

The *Engineering Alumni Watch Award* is presented to the fifth-year engineering student adjudged by the faculty to have achieved the outstanding scholastic record during his undergraduate work at Rice

The *Featherlite Corporation Award* is offered by the Featherlite Corporation to a fourth-year architectural student on the basis of an architectural design competition.

The *Meador Dean Francis Award* is offered each year by Tau Beta Pi to the outstanding Junior engineering student.

The *Max Freund Prize* was established in 1954 by former students of Professor Emeritus Max Freund for a student of high academic standing who is pursuing a course of study in German language or literature.

The *Lady Geddes Prize in Writing* is awarded annually on the basis of a competition which is open to all Freshman and Sophomore students of Rice University.

The *Hamilton Watch Award* is provided by the Hamilton Watch Company for the fifth-year engineering student who has most successfully combined proficiency in his major field with notable work in the humanities.

The *Claude W. Heaps Prize in Physics* has been awarded annually since 1960 to an outstanding undergraduate student in physics. The prize, provided by students and friends of the late Professor Heaps, serves to honor his memory.

The *Robert Pilcher Quinn Award* is presented annually to a student who has demonstrated outstanding qualities in athletics, leadership, scholarship, and sportsmanship.

The *James S. Waters Creativity Prize* was established by an anonymous donor in 1965. It is a competitive prize awarded annually to an undergraduate student in engineering.

The *Eloise Szabo Witte Studentship* in history is awarded to the member of the Freshman class who has demonstrated the greatest promise in that subject and has indicated a desire for further study of history, preferably Biblical or ancient history.

Student Life

Student Responsibility

Each member of the University community is expected to govern his conduct by standards of good taste and ethical judgment and to exercise his responsibility even when these standards are disregarded by others. It is assumed that students, having voluntarily enrolled in that community, will be responsible members who will abide by the regulations and accepted practices of the University until such time as these may be changed by orderly procedure.

Rice University encourages student self-government and self-discipline within the framework of its general objectives. It is the responsibility of the University to examine continuously its presuppositions and practices. Students are encouraged to participate in this process through appropriate investigation, questioning, discussion, and criticism.

While Rice University generally does not attempt to regulate the behavior of individuals off campus, it does have a proper concern with any behavior on or off campus which may bring discredit or harm to an individual or to the University.

Any individual or collective enterprise using the name of the University or its Colleges is required to have prior approval of University officials.

The University reserves the right to require the withdrawal of any student who fails to accept his responsibility, as evidenced by conduct or scholastic achievement considered detrimental to his own or the University's best interests. Such action is required only after careful consideration by appropriate agencies of the student government and/or officials of the faculty and administration.

The Honor System

One of the oldest and proudest of the traditions at Rice is its honor system administered by a student Honor Council whose members are elected annually by the student body. Adopted by a vote of the student body in 1916, the system has remained essentially unchanged, except for changes in procedures and membership of the Honor Council to reflect changes in the University. One of the most significant of these changes currently under study is the recent development of a sizeable graduate student body.

All written examinations and certain specifically designated assignments are conducted under the honor code. The student body, through its commitment to the honor system, accepts responsibility for assuring the validity of all examinations and assignments conducted under the system. The Honor Council is responsible for investigation of all reported violations and for trial in those cases where the facts warrant. The Dean of Students reviews the results of investigations and trials and acts upon recommendations for penalties. The Honor Council conducts a continuing program to orient new students and faculty members to the responsibilities and privileges of the system.

The Residential Colleges

On entering Rice, every undergraduate student becomes and thereafter remains a member of one of seven colleges. Baker, Hanszen, Wiess, Will Rice and the newly erected Lovett College to be opened early in the 1968-69 academic year are men's colleges. Margaret Root Brown and Mary Gibbs Jones are the colleges for women. Each of the colleges is a self-governing community of students, whose elected officers and representatives have powers commensurate with their responsibilities for maintaining not only an orderly routine of daily life, but also broad social, cultural, and athletic programs. Among the colleges, the memberships are approximately equal, with all the academic disciplines proportionately represented. While uniformity has not been sought and practices differ from college to college, all are alike in seeking to foster in their members the intellectual awareness and the sense of individual honor and group responsibility that distinguish educated persons. Each college has a Master who, with his family, occupies the Master's House adjacent to the College. The Masters of the colleges have direct responsibility for all aspects of student life in their respective colleges. They are particularly responsible for stimulating intellectual and cultural interests, for encouraging student self-discipline and good behavior, and for the development of effective student government within the colleges. In the women's colleges, the Associate Dean of Students works closely with the Masters in matters of counseling and discipline. Other members of the faculty are selected by the Masters, with the advice of the members of the colleges, as resident and nonresident Associates to assist the Masters in carrying out their responsibilities.

Upon acceptance by the University, each undergraduate student will be designated a member of one or another of the colleges. Two students who are entering Rice for the first time may ask to be assigned to the same college, but may not designate which college. A new student may request membership in the same college as a close relative. No other choice of college can be allowed.

The buildings of each college include a dining hall and common rooms, available to resident and nonresident alike, as well as quarters for an average of about 215 students of all classes. Rooms in the men's colleges are completely furnished except for linens, window drapes, and rugs. Rooms in the women's colleges are completely furnished except for linens and rugs.

Student Government and Activities

Student Government

All undergraduates are members of the Rice Student Association This organization of the student body is governed through the Student Senate, made up of the five elected officers of the Student Association, the president of the Freshman class, two senators from each college, and an off-campus senator elected from the student body at large. Except for those student functions under the colleges, all student activities are directly or indirectly under the jurisdiction of the Student Senate. In addition, each of the five classes—Freshman, Sophomore, Junior, Senior, and Class II Graduate—has its elected officers.

Most disciplinary offenses are tried in student courts. The Honor Council, as noted above, administers the honor system and conducts hearings and trials for offenses against it. Each college has a court which enforces college and University regulations among its members. An Inter-College Court has authority over offenses by student organizations and may act upon request in matters of an all-school nature involving members of more than one college. The University administration retains ultimate authority and responsibility in all matters of discipline.

Student Activities

In addition to the many activities of the residential colleges, there is a variety of campus-wide student activities. The official publications include the *Thresher,* the weekly campus newspaper, and the *Campanile,* the University annual. A student literary magazine, *Janus,* is published from two to three times a year. Rice engineering students publish the quarterly *Rice Engineer.* A Student Forum Committee sponsors a series of speakers on issues of current interest.

Student organizations are numerous. Many are associated with special academic and professional disciplines. These include the foreign language clubs, the Architectural Society, the student affiliate of the American Chemical Society, and student branches of the American Institute of Aeronautics and Astronautics, the American Institute of Chemical Engineers, the American Institute of Physics, the American Society of Civil Engineers, the American Society of Mechanical Engi-

neers, the Association for Computing Machinery, and the Institute of Electrical and Electronic Engineers. The Army and Navy R.O.T.C. students have the Chevron and the Sextant, respectively, to represent their special interests. A Film Guild, a Forensic Society, and a Sports Car Club exist for those interested in these matters. The Rice Players is a dramatic group sponsored by members of the faculty. For the musically inclined there are the Rice Band and other musical and choral groups. Students with active political interests may affiliate with the Young Democrats or the Young Republicans.

Women Students may affiliate with one of the three literary societies—the Chaille Rice, the Elizabeth Baldwin, or the Owen Wister. The Rally Club is a special service organization for men.

Rice students are affiliated with a number of denominational religious organizations. These include the Baptist Student Union, the Canterbury Association, the Christian Science Organization, the Hillel Society, the Lutheran Student Association, the Newman Club, the United Campus Christian Fellowship, and the Wesley Foundation. These organizations are represented on the Student Interfaith Council, a group chartered by the Student Association.

Through the generosity of the late Mrs. James L. Autry, as a memorial to the late James L. Autry of Houston, the Diocese of Texas of the Protestant Episcopal Church maintains Autry House in the immediate vicinity of Rice University as a social and religious center. The cornerstone of Autry House was laid during the commencement ceremonies of the Class of 1921. To this community group of the Episcopal church, the late Mrs. E. L. Neville of Houston, in memory of her brother, contributed the beautiful Edward Albert Palmer Memorial Chapel, which was dedicated November 27, 1927. All the opportunities of these establishments are available to the students of Rice Universiy irrespective of religious affiliation.

Student Association Service Award

In memory of Hugh Scott Cameron, first Dean of Students at the University, the Student Association annually presents the Rice Service Award, in the form of a bronze medallion, to those currently enrolled or former students who have been most exemplary in rendering distinguished service to the school and to the student body. This coveted honor is sparingly bestowed after careful consideration of possible recipients by a committee of faculty and students appointed by the Association.

The Student Health Service

Rice University operates a Student Health Service to give prompt attention to the acute medical needs of its students. Any student,

graduate or undergraduate, may avail himself of the services offered by presenting himself in the clinic located in Hanszen College or the substation located in Jones College, South. A registered nurse is on duty during school hours; qualified attendants are available at all hours.

Physicians in the Health Service offer care for the treatment of acute illnesses and injuries. All chronic ailments or medical conditions requiring extensive investigation are referred to nearby practicing physicians for consultation, as are the more severe illnesses and injuries that require hospital treatment.

Medical care given on campus by the Health Service is covered by the annual Health Service fee. Additional medical care, hospitalization, extensive laboratory tests and prescriptions are not covered by this agreement. Most medications given to the student from the Health Service are free of charge. However, a small charge is made for some of the more expensive antibiotics. Immunizations are available as needed in the Health Service at no charge to students.

It is highly recommended that all students avail themselves of the group health insurance made available to all students of the University. Application forms may be obtained from the secretary of the Health Service. This insurance covers hospital charges, part of the physician's charges when the patient is hospitalized, and also a portion of laboratory and consultation charges when a student is seen in a private physician's office.

Closely associated with the Student Health Service, the University Psychiatric Service seeks to provide help to students or faculty who may need its services. Consultation service is provided without charge. In some instances, it is also possible to offer brief treatment on a no-fee basis. When it is clear that more prolonged work is necessary, the individual may be referred to a private physician or a low cost clinic, as indicated. The services are available on an appointment basis in an office located on the campus. In addition, an attempt is made to have some time available for "drop in" visits during regular office hours. An appointment may be made directly by a student, or anyone he delegates, at either the campus office or at the doctor's office at Baylor University College of Medicine. Certain provisions have been made for emergency situations occurring outside of office hours. The confidential relationship of the doctor and patient is carefully maintained as necessary to the effectiveness of the Service.

Memorial Center Facilities

The Rice Memorial Center was built through the generosity of friends and alumni. Ground was broken for this building on November 9, 1957, and it was dedicated on Homecoming weekend in the fall of 1958. The center and chapel comprise a memorial to those

Rice alumni who have died in the service of their country, and provision was made in the plans for commemorative inscriptions.

The center includes a chapel with associated offices. The chapel is utilized for regular nondenominational religious services, directed by a faculty committee with the assistance of a student chapel committee.

The center provides offices for the Dean of Students, the Association of Rice Alumni, the Student Association, the Honor Council, and various student publications. It also contains the Campus Store and Sammy's, the snack bar, as well as lounge and ballroom facilities.

Athletics

Rice is a charter member of the Southwest Athletic Conference and participates in the intercollegiate athletic contests sponsored by the conference. Football games are played in the 70,000-seat Rice Stadium and basketball in the Autry Court in the Rice Gymnasium.

There is a very active program on intramural athletics in both team and individual sports. Facilities include an indoor swimming pool, tennis, handball, and squash courts, gymnastic rooms, and playing fields.

Student Automobiles

All students at Rice currently enjoy the privilege of bringing automobiles on the campus. All such automobiles, however, must be registered with the Office of the Dean of Students at the beginning of the school year or whenever first brought on the campus. Desirable park ing spaces are at a premium, and any student operating an automobile on the campus may park only in the areas assigned. Off-campus students have two options. They may park without payment of fee in the Stadium lot, or they may pay a nominal annual fee entitling them to park in special Commuting Student lots. Any automobiles parked or operated on the campus are there solely at the owner's risk. Failure to abide by the regulations will result in monetary fines for specific offenses and the withdrawal of driving privileges in the case of flagrant abuses. Copies of the *University Traffic and Parking Regulations* may be obtained from the Office of the Dean of Students.

Part Four

Information for Graduate Students

General Information
Areas of Study and Degrees
Requirements for Professional Degrees
Requirements for Research Degrees
Admission to Graduate Study
Tuition, Fees, and Expenses
Fellowships, Scholarships, and Prizes
Graduate Student Life

General Information

Since the opening of the University in 1912, then the Rice Institute, the emphasis has been on scholarship, and graduate study and research have been carried on as a principal means of advancing knowledge. The first Doctor of Philosophy degree was awarded in 1918 in Mathematics. Since that time graduate study has been expanded through the basic sciences, the humanities, engineering and, more recently, economics and the behavioral sciences, and the number of graduate students steadily increased. Within the next few years expansion will continue. The number of graduate students is expected to increase from about 700 to around 1,200 and additional fields will be open to graduate study, probably in the social sciences and in interdepartmental areas.

Areas of Study and Degrees

Graduate study is offered in two broad categories. Research oriented programs in the Graduate Division lead to the Doctor of Philosophy degree, the Master of Arts degree or the Master of Science degree. Professional degrees beyond the baccalaureate are offered in Engineering.

The degree of Doctor of Philosophy is awarded in biology, behavioral science, chemical engineering, chemistry, civil engineering, economics, electrical engineering, English, environmental science and engineering, French, geology, German, history, mathematics, mechanical and aerospace engineering and materials science, philosophy, physics, and space science. Various areas of specialization are available within these fields of study.

The degree of Master of Arts is available in the humanities and scientific fields of study including the social sciences and the Master of Science degree may be obtained in the fields of chemical, civil, electrical or mechanical and aerospace engineering and materials science. The Master in Architecture is also offered. Professional degrees of Master of Chemical Engineering, Master of Civil Engineering, Master of Electrical Engineering, and Master of Mechanical Engineering are also awarded.

For specific information refer to the statements of the various departments in *Part Five,* pp. 113-242. Additional information is available from the Chairman of each of the Departments. Prospective students are encouraged to write the Chairman of the Department of interest for a pamphlet or bulletin of information or for answers to specific questions.

Requirements for Professional Degrees in Engineering

Candidates for the Master's degree in a specified branch of Engineering are required to complete ten semester-courses satisfactorily and be recommended for the degree by the department of specialization. The ten courses submitted must be approved by the student's advisor in his major department. Two of the ten courses must be Group A or B courses (see p. 54). In addition the student must have completed the courses of the first four years of the Rice engineering curriculum, or satisfactory equivalents.

Chemical Engineering. Flexibility in course planning permits specialization in such areas as economics, nuclear engineering, reservoir engineering, process control, optimization and systems analysis, applied mathematics, material science, kinetics and catalysis. Each student is registered in a departmental seminar and laboratory in addition to his required ten courses.

Civil Engineering. The detailed program of each student is formulated in consultation with his departmental advisor. Flexibility in course requirements permits some specialization in structural engineering and mechanics, soil mechanics and soils engineering, environmental engineering, or applied mathematics.

Electrical Engineering. Technical electives permit some specialization in the general areas of systems and information theory, solid-state and physical electronics, and computer science.

Mechanical Engineering. For properly qualified students, flexibility in course requirements premits specialization in aerospace engineering, engineering mechanics, fluid dynamics, heat transfer, or materials science.

Requirements for Research Degrees

Residence

The Doctor of Philosophy degree is awarded after the successful completion of a program of advanced study extending to the frontier of knowledge and an original investigation reported in an approved thesis. Normally, three or more years of study are required after admission to graduate study. At least two years of full-time study, or the equivalent of 60 semester hours, must be in residence at Rice. As final evidence of his preparation for this degree, the candidate must pass a public oral examination.

The Master of Arts, Master in Architecture, or Master of Science degree may be obtained after completion of at least 30 semester hours of study including the thesis, 24 of which must have been in residence at Rice. Programs will generally include a piece of original work embodied in a thesis, and the candidate's preparation will be

evidenced by a public examination. Students whose undergraduate preparation has not included sufficient advanced work usually will require at least two years to complete the requirements for a Master of Arts, Architecture, or Science.

Language Requirements

Foreign language requirements for the Master's and Doctor's degrees are established by the individual departments according to the need for foreign languages in the conduct of research and scholarship in their respective fields.

Approval of Candidacy

Students seeking the master's or doctor's degree must submit a petition through their departmental chairman to the Graduate Council for the approval of candidacy. The chairman will certify that the applicant has fulfilled the University requirement of the qualifying examination, that he has passed the foreign language tests, and that the character of his own work within the department is of high quality.

The final thesis oral examination can be given only after the candidacy has been approved by the Graduate Council.

Applications for the approval of candidacy for the Ph.D. degree must be filed in the Graduate Office prior to November 1, and for the master's degree prior to March 1, of the academic year in which graduation is expected. The student must have been approved for the candidacy for the Ph.D. before the end of his sixth semester of residence at Rice in order to be eligible for continued financial support. Appointments and support of graduate study are not continued for more than four years except in legitimate cases approved by the Graduate Council.

Oral Examinations

The committee for the oral examination is appointed by the Graduate Council at the time the candidacy is approved. The oral committee consists of at least three members: the thesis director, one other member from the department, and one member in a related field outside the department.

It is the responsibility of the candidate to inform the members of his committee of the nature of his research and his progress; before March 15 the members of his committee must approve his thesis in preliminary form.

The oral examination may be scheduled at any time prior to the first Friday of Examination Week of the academic year in which the degree is expected, provided that the examination is announced in the Rice weekly Calendar of Events the previous week. In appropriate circumstances an oral examination may be scheduled during the summer. The posting of notice of the time and place of the exami-

nation on the bulletin board of Fondren Library the preceding week will be acceptable as the public announcement.

The length of the examination and the character of the subject matter on which the candidate will be examined is left to the judgment of the committee. In the event of the failure of the candidate, the chairman may reschedule the examination a second time. In the event of a second failure, the student will be required to withdraw from the University.

Thesis Regulations and Procedure

The thesis is the principal record of work for an advanced degree. It will be bound in buckram and permanently preserved in the library, and it is important that the standard form indicated in the directions provided upon approval of candidacy be followed. Copies of these instructions may be obtained from the Graduate Office.

More specific information about requirements for advanced degrees in each field of study is given under department headings in the section of this catalog describing course offerings, which begins on page 113.

By special arrangment with the head of the department in which he is specializing, a graduate student who is already a candidate for an advanced degree may enroll in an approved research course during the summer. Such enrollment will be for a twelve-week period starting with the end of the regular academic year. The registration fee and appropriate laboratory fees will be charged.

Admission to Graduate Study

Graduate study is open to well-qualified students who possess adequate background in the field of study the candidate wishes to pursue. Normally, but not always, the equivalent of an undergraduate major in the field is required, but the final judgment of preparation rests with the department concerned; the emphasis is on the quality of the applicant's preparation rather than on the academic program pursued or credits earned in achieving it. A bachelor's degree is not a necessary prerequisite to admission to graduate study.

Professional Degrees in Engineering

Applicants who are in the fourth year of the engineering curriculum at Rice make application to the Chairman of the department in which professional study is to be pursued. A prospective applicant who has not obtained undergraduate engineering training at Rice should write to the Dean of Engineering and Science for application forms and information.

Research Degrees

An applicant for admission to graduate study for research degrees should address all communications to the chairman of the department in which he wishes to study. The chairman will provide the relevant information about the graduate program and the appropriate application form. The completed form, with the transcript and photograph, should be returned to the chairman of the department. After the members of the staff have made a preliminary evaluation, the application form with the letters of recommendation will be transmitted by the chairman to the Graduate Council for final action. Candidates are evaluated on their previous academic records, test scores available and their qualifications to pursue advanced study. Their capability for research is primarily determined through references from scholars under whom they have studied.

In addition to any specific requirements of the department, the applicant will be expected to have at least a "B" average in his undergraduate work. Preference will be given to applicants who earn high scores on the Graduate Record Examination. Arrangements to take this examination may be made directly with the Educational Testing Service, 20 Nassau Street, Princeton, New Jersey. Applicants in the Houston area may also apply in person to the Graduate Office at Rice for the necessary forms.

Normally, departments will provide all graduate students with a limited amount of teaching experience as part of their training for advanced degrees.

Interdisciplinary programs in systems theory leading to the degree of Doctor of Philosophy are open to students with backgrounds in mathematics, applied mathematics, engineering, physical science, or social sciences. Programs of instruction utilize common courses in systems theory and applied mathematics, as well as specialized courses in the areas of principal research interest. A student working in systems theory is enrolled in one of the participating departments offering an advanced degree program in systems theory. Currently, these programs are available in the departments of Chemical Engineering, Economics and Business Administration, Electrical Engineering, and Mathematical Sciences. These programs are highly interdisciplinary in nature and do not necessarily require an undergraduate major in the area of primary interest to the department. Supporting courses and research activities are available in a number of cooperating departments, including mathematics and the behavioral sciences. Courses and research interests include: Algorithm Theory, Artificial Intelligence, Biological Systems, Chemical Systems, Economic Development, Information Theory, Mathematical Programming, Modelling, Modern Control Theory, Network Theory, Operations Research and Economics, Optimization, Stability Theory, and Statistical Communica-

tion Theory. For applications or additional information, contact the chairman of one of the following departments: Chemical Engineering, Economics and Business Administration, Electrical Engineering, and Mathematical Sciences.

An interdisciplinary program in solid-state electronics and materials science leading to the degrees of Master of Science or Arts and Doctor of Philosophy is open to students with backgrounds in engineering or physical science. The course program consists of a common group of courses taught jointly by the participating departments. These basic courses are followed by more specialized courses and seminars given by the individual departments. Interdepartmental seminars are also offered. The research leading to the degrees is normally supervised by an interdepartmental research committee. The student is enrolled in one of the participating departments, currently Chemistry, Electrical Engineering, Mechanical Engineering, and Physics. However, the program is sufficiently flexible to accommodate students who do not necessarily have the corresponding undergraduate major. Current courses and research interests include the areas of Anelasticity, Electrical Conductivity, Electron Microscopy, Fermi Surfaces, Ferroelectrics, Ferromagnetism, Lasers and Masers, Lattice Theory, Microwave Devices, Nuclear Detectors, Semiconductor Devices, Solid Solutions, Thin Films, and Transport Phenomena. For applications or additional information contact the Chairman of one of the following departments: Chemistry, Electrical Engineering, Mechanical Engineering, or Physics.

The degree of Master of Arts is available in the humanities and scientific fields of study, and the degrees of Master in Architecture or Master of Science may also be obtained, the latter being awarded in chemical, civil, electrical, or mechanical engineering.

Tuition, Fees, and Expenses

Tuition for full-time students enrolled in the Graduate Division is $1,700 per year, payable $850 at the beginning of each semester. In addition, each graduate student pays an annual Health Service fee of $17.

The graduate programs at Rice University are designed for full-time study, but, in special circumstances, students are admitted to graduate study on a part-time basis. For students who have been admitted to graduate study on a part-time basis, tuition is $90.00 per semester hour plus $50.00 registration fee each semester or summer period. The application of each such student must be clearly marked "Part-time" and initialed by the Department Chairman or a member of the faculty designated by him. Otherwise the student will be charged the full tuition rate of $1700 per year.

On the registration card of a part-time graduate student enrolled in "Research" or "Thesis" the adviser should designate the number of semester hours for which the student is to be charged. When this is not done, it will be assumed that the number of hours of "Research" or "Thesis" is sufficient to bring his total load to six semester hours each semester, and tuition charged accordingly.

Students who have completed all work for an advanced degree except certain examinations and/or completion of a dissertation and are *not on campus* must be registered for the spring semester of the year in which the degree is to be awarded. Such students will be required to pay only the $50.00 registration fee. The Registrar will accept registration and fees in advance, prior to the student's leaving the campus, if desired.

Any student who is pursuing any phase of his graduate study *on campus* must be registered and pay appropriate tuition and fees, even though he is not engaged in course work.

All foreign students are required to carry health insurance; the annual cost is approximately $26 for an individual, $65 for a couple, or $95 for a family. This expense is not included in the tuition or fees.

A graduate student may purchase a Student Athletic Card, at a cost of four dollars, which will entitle him to admittance to all regularly scheduled athletic events. If married, he may purchase a season ticket for his wife at a reduced rate of one half the regular price, provided the season ticket is purchased at the beginning of the fall term.

Fellowships, Scholarships, and Prizes

Fellowships

Provision is made for a variety of fellowships available to graduates of this and other universities. There are several memorial fellowships that have been founded and endowed by gift or bequest on the part of friends of Rice University. These provide a stipend designed to enable the holder to devote his time to study and research in his chosen field. There are also several industrial fellowships maintained by companies interested in the development of technical fields and the training of competent scientists and engineers.

Persons desiring to be considered for appointment as fellows should consult with the department in which they desire to work.

M. D. Anderson Fellowships in physics.

Ora N. Arnold Fellowship Fund. Graduates of Rice University or of Mexico may be appointed. An incumbent from Rice may study in Mexico, the South American states, the West Indies, or the Philip-

pine Islands; an incumbent from the University of Mexico is expected to study at Rice University.

Atlantic Refining Company Fellowship in Chemical engineering.

Eleanor and Mills Bennett Fellowships in hydrology.

Samuel Fain Carter Fellowship for graduate study in economics.

Celanese Corporation Fellowship in chemical engineering.

Continental Oil Company Fellowship in chemical engineering.

M. N. Davidson Fellowship in architecture. Awarded to a fifth-year student.

Camille-Henry Dreyfuss Fellowship in chemical engineering.

Dow Chemical Company Fellowship in chemical engineering.

Eastman Kodak Research Grant in chemistry.

Ethyl Corporation Fellowship in chemical or mechanical engineering.

Ideal Cement Company Fellowship in civil engineering.

Edgar Odell Lovett Fellowship in mathematics.

Mrs. L. F. McCollum Fellowship.

National Aeronautics and Space Administration Traineeships.

National Defense Education Act Fellowships.

National Institute of Health Traineeships.

National Science Foundation Traineeships.

Petroleum Research Fund of the American Chemical Society. Fellowship in chemistry

Phillips Petroleum Company Fellowship in mathematics.

Schlumberger Foundation Fellowship in mathematics.

Shell Oil Company Fellowships. One fellowship is available for study in physics and another for study in mechanical engineering.

Suit Graduate Fellowship in Architecture. Awarded to a Latin American student.

Sun Oil Company Fellowship in chemical engineering.

Texas Company Fellowship in electrical engineering.

Union Carbide Fellowship in Chemistry.

United States Public Health Service Traineeship Awards in environmental engineering and biology.

Robert A. Welch Foundation Fellowships.

Rice Graduate Fellowships

Graduate students with high academic records and outstanding qualifications may receive assistance through awards of Rice University Fellowships. The stipend for these appointments range up to $3,200 for a twelve-month tenure or three-fourths of the stated amount for nine-month tenures. Rice University Fellowships provide an additional grant of $1700 for the tuition.

In some departments, Rice Teaching Assistants may be awarded to advanced (third- or fourth-year) students. If exceptional teaching ability has been demonstrated, appointments known as Teaching Associates are available.

Graduate Tuition Scholarships

Students whose previous records show marked promise but for whom no graduate fellowships are available may, especially in their first year of graduate study for a research degree, be awarded graduate tuition scholarships without stipend. Graduate scholars may carry a full schedule of graduate work.

Tuition grants based on need for financial assistance are available to students in the professional master's degree program. Normally Rice students who have received tuition grants from the University during their undergraduate years may anticipate continuation of assistance as needed for the year of professional study. Others must file the P.C.S., which is the usual application for financial assistance through the College Scholarship Service. Information is available from the Financial Aid Office, the Dean of Engineering and Science, and the chairman of the engineering departments.

Other Graduate Fellowships

In addition to the above fellowships students may also pursue advanced studies through Woodrow Wilson Fellowships and National Science Foundation Fellowships as well as by awards made from grants to the University through such agencies as the Atomic Energy Commission, the National Institutes of Health, and the National Aeronautics and Space Administration.

The Committee on Graduate Instruction processes applications for fellowships submitted by graduate students of Rice University for research in other institutions and in other countries. Among available fellowships of this nature are the Rotary International Fellowship, the Rhodes Scholarships, the Frank B. Jewett Fellowships awarded by the Bell Telephone Laboratories, and the National Science Foundation Fellowships.

Honors and Prizes

The *Ralph Budd Award* is a medal given for the best thesis in engineering.

The *William Dunlap Darden Memorial Award* is granted on the basis of achievements and contributions as demonstrated by the master's thesis in architecture.

The *John W. Gardner Award* is a medal given to a student presenting outstanding achievement in research in the humanities or social sciences.

The *Sigma Xi Awards* are given annually by the Rice University Chapter of the Society of the Sigma Xi for proficiency in research. Candidates for degrees at both the master's and doctor's level are eligible.

The *H. A. Wilson Memorial Award* provides a substantial prize for the best research in physics by a graduate student.

Graduate Student Life

Rice University encourages student self-discipline within the framework of its general objectives. It is the responsibility of the University to examine continuously its presuppositions and practices. Students are encouraged to participate through appropriate examination, questioning, and criticism. Each member of the community, however, is expected to govern his conduct by standards of good taste and ethical judgment and to exercise his responsibility even when these standards are disregarded by others. It is assumed that students, having voluntarily enrolled, are in accord with the objectives and philosophy of the University and will abide by its regulations and accepted practices.

An individual or collective enterprise using the name of the University or its colleges is required to have the approval of University authorities. While Rice University generally does not attempt to regulate the behavior of individuals off campus, it does have a proper concern with any behavior on or off campus which may bring discredit or harm to an individual or to the University.

The University reserves the right to require the withdrawal of any student who fails to accept his responsibility, as evidenced by conduct or scholastic achievement considered detrimental to his own or the University's best interests.

The Honor System

Graduate students are expected to observe the provisions of the honor code. The provisions of the honor system are summarized on p. 91.

Housing

At present the University has no housing on the campus for graduate students. However, within walking distance of the campus there are many rooms and apartments for rent at reasonable prices. For the convenience of new students, the Dean of Students keeps a record of rooms and apartments about which he has been notified, and the daily newspapers list still others. Incoming graduate students are advised to arrive in Houston a day or two early in order to find lodging.

Occasionally room and board for a graduate student may be available in one of the undergraduate residential colleges. A graduate student wishing to be considered for such a room may write to the Dean of Students asking to be put on the waiting list. It will be advisable, however, to assume that lodging must be found off campus, since obtaining an accommodation on the campus is unlikely and since the dean may not know before the term begins about vacancies in the colleges.

The Student Health Service

A Health Service is maintained on campus to provide immediate medical attention as needed and assistance in treating minor ailments. Limited psychiatric consultation is also available. For more information about the services provided refer to page 94.

Part Five

Courses of Instruction

Courses of Instruction

Course descriptions are listed alphabetically by departments of instruction. For most of the departments these descriptions are preceded by statements of specific requirements for students majoring in the department both at the undergraduate and the graduate levels. These statements are supplemental to the general degree requirements described on pages 53-62, 99-104.

Courses numbers below 200 designate courses designed primarily for Freshmen; courses numbered from 200 to 299 are considered second-year courses and are open to Freshmen only with permission. Numbers from 300-499 are designated as advanced courses. They are open to students of the lower classes with permission and to graduate students on approval of the individual student's adviser.

Courses designed for graduate students are numbered 500 and above. The methods of presentation and quality of work expected make them generally unsuited to undergraduate participation. Hence an undergraduate is permitted to enroll in a graduate-level course only after consultation with his adviser and with the instructor of the course.

The letters "a" and "b" following the course numbers indicate first-semester and second-semester courses respectively. Thus, History 200a is taught only the first semester and History 201b only the second semester. Courses for which the number is not followed by a letter "a" or "b" may be taught either semester. When consecutive courses are shown with a single listing, as Biology 100a, b or Anthropology 370a, 371b, the first-semester course is prerequisite to the second.

Figures entered in parentheses following the title of each course signify the number of class hours per week, the number of laboratory hours per week, and the semester-hours credit for the completed course, in that order. Thus, the entry (3-3-4) in Biology 360a means that the course meets three hours per week, has three hours of laboratory work per week and is evaluated at four semester-hours credit upon completion of the semester's work.

Architecture

Professors Caudill, *Director,* Evans, Morehead, Ransom, Todd
Associate Professors Mitchell, *Associate Director,* Krahl, and Newton
Assistant Professors Leifeste, Mabe, Papademetriou, Schorre, and Wong
Lecturer Dyess
Visiting Lecturer Kennon

Preceptors, Plan A
Richard L. Aeck, F.A.I.A., of Aeck Associates, Atlanta, Georgia
Harris Armstrong, F.A.I.A., Kirkwood, Missouri
O'Neil Ford, F.A.I.A., of O'Neil Ford and Associates, San Antonio, Texas
E. G. Hamilton, A.I.A., Harrell and Hamilton Dallas, Texas
George S. Hellmuth, A.I.A., Hellmuth, Obata, and Kassabaum St. Louis, Missouri
John Lyon Reid, F.A.I.A. San Francisco, California
E. Davis Wilcox, A.I.A. Tyler, Texas
Gordon G. Wittenberg, F.A.I.A., Wittenberg, Delony, and Davidson, Inc. Little Rock, Arkansas

Preceptors, Plan B
E. C. Bassett, A.I.A., Skidmore, Owings, and Merrill San Francisco, California
Thomas A. Bullock, A.I.A., Caudill, Rowlett, Scott Houston, Texas
William J. Geddis, A.I.A., The Architects Collaborative Cambridge, Massachusetts
Walter A. Netsch, Jr., A.I.A., Skidmore, Owings, and Merrill Chicago, Illinois
I. M. Pei, F.A.I.A., I. M. Pei and Partners New York, New York
Kevin Roche, A.I.A., Kevin Roche, John Dinkeloo, and Associates Hamden, Connecticut

The profession of architecture is concerned with the physical environment of man. Each civilization, by its buildings and spaces, leaves a tangible record of its aims and beliefs through the expression of architecture. As contemporary society becomes increasingly urban, the

architect's role in society is also becoming oriented toward urban problems in addition to the more traditional practice. The School of Architecture is fortunate to be located in metropolitan Houston, the South's largest city. The city offers students a wide range of professional associations and cultural activities. The Houston area is characterized by rapidly expanding population and accelerated building activity. The school uses the city as a teaching laboratory and its great variety of architectural examples—past, present, and under construction—as case studies.

Three degrees are offered: Bachelor of Arts, Bachelor of Architecture, and Master in Architecture. The undergraduate curriculum for the study of architecture is an accredited five-year program. After successful completion of the first four years of this program, the Bachelor of Arts degree is awarded. At this time the candidate's work is evaluated before he is admitted to the fifth year, which leads to the professional degree of Bachelor of Architecture. The Master in Architecture degree is offered for graduate study by candidates already holding a professional degree in architecture.

All work at each class level is offered in a single course dealing with the three areas of knowledge requisite to the practice of architecture: *Design, Technology,* and *Management.* At each level a professor of architecture directs the integrated program for the year and coordinates the instruction of a team of specialists in these three areas. The student body, selected on a highly competitive basis, is small. Because of this, it is possible to give special attention to each student in small studio groups. Through the flexibility inherent in an integrated program, each student is allowed the freedom to develop his own capabilities and talents. Special programs are devised to encourage the student to progress at a rate commensurate with his abilities and interests.

In addition to the basic requirements of the University, students supplement their work in architectural studies through required and elective courses in various departments of the Division of Humanities, particularly in Fine Arts, for the history of art and for studio art courses in drawing, painting, and sculpture.

Supplementing the regular academic instruction are several auxiliary programs designed to span the gap between school and practice: the Rice Design Fetes, the Preceptorship Programs, the visiting lecturer and visiting critic series. The Rice Design Fete is a research program in which outstanding practicing architects return to a university atmosphere and students are involved in professional design responsibilities during a two-week work session on the campus with the purpose of completing program analyses and architectural solutions for a specific building type selected by a research sponsor. In addition, outstanding students of the school are selected to participate in the Preceptorship programs designed to span the gap between classroom studio learning and professional practice. Under the pro-

gram, students work and study with noted professional architects designated by the school as preceptors. There are two Preceptorship programs now in effect. Plan A places students with preceptors for two-to-three-week periods during the academic year. Plan B allows students to work and study with their preceptors for an entire year, scheduled between the fourth and fifth years of study on the Rice campus. The school also publishes a series of reports on investigations and thoughts from the School of Architecture titled *Architecture at Rice.* It is published in the belief that the education of architects can best be advanced if teachers, students, practitioners, and interested laymen share in what they are thinking and doing. Twice annually, ending the fall and spring semesters, outstanding practicing architects of local ond national significance are invited to participate in Jury Week during which each student's work—from the sophomore through the graduate class—is evaluated by a jury consisting of faculty and visitors. In essence, the school offers a broad course in architecture tied closely to the profession and based on an intense liberal arts background.

Graduate Program in Architecture. The program leading to the Master in Architecture degree is concerned with the design of the total physical environment. The scope of investigation, study, and design involves the broadest aspects of regional and urban design as well as the more particular design of specialized building types, technology, artifacts, and furniture. The emphasis is upon the development of the individual with each candidate's program specifically geared to his background and abilities, his rate of progress, and his professional orientation. The method is by guidance through comparative analysis of different architectural solutions to develop in the candidate self-criticism and self-direction. The graduate program is carried as Architecture 601a, 602b and consists of three phases:

1. An educational program to clarify architectural ideas and to achieve an assimilation of architectural principles by means of a series of problems on a class basis.
2. The selection of an area for research toward a thesis.
3. The clarification of the thesis and the development of a demonstration in the nature of a creative design.

Each candidate for the master's degree must take Architecture 601a, 602b and one advanced course outside the School of Architecture. Each candidate is assigned a faculty member as a thesis director, and the final presentation is made before a jury of faculty and visiting specialists.

Courses

Architecture 101a, 102b. Principles of Architecture (2-6-4, each sem.).

a. Design: Communicative skill in various media; introduction to principles of design and their application to architecture; elementary architectural prob-

lem-solving; selected readings and essay composition; tours of museums and galleries.

b. Technology: Introduction to the characteristics of materials; principles of elementary structures; field trips to buildings under construction; awareness of mechanical equipment in buildings; architectural nomenclature.

c. Management: Introduction to the profession and the place of the professional in society; introduction to allied professions; visits to architectural offices; review of current office organization and operation of professional practice.

Laboratory fee required. *Staff*

Architecture 201a, 202b. Principles of Architecture (2-16-7, each sem.).

a. Design: Application of basic architectural principles to single buildings—one- and two-story; short problems in interior design, landscape planning, and product design; house and neighborhood planning; study of environmental design determinants—physical and social.

b. Technology: Design of simple structures in wood and masonry; basic principles in applications of plumbing, electrical, and mechanical systems; strength of materials; introduction to structural and design potential of basic building materials.

c. Management: Organization of time; client relations; study of cost controls; professional responsibilities.

Laboratory fee required. *Staff*

Architecture 301a, 302b. Principles of Architecture (6-18-12, each sem.).

a. Design: Variety of architectural design problems with one project completely developed in detail; housing and community planning.

b. Technology: Structural theory in wood, steel and concrete; application of plumbing, electrical, and mechanical systems to design problems; performance, standards and selection of materials; strength of materials; inspection trips of illustrative construction.

c. Management: Study of professional ethics; visits to architectural offices; discussions with prime consultants in architectural practice.

Laboratory fee required. *Staff*

Architecture 401a, 402b. Principles of Architecture (6-18-12, each sem).

a. Design: Advanced design problems of complex nature—multistory buildings and groups of buildings; philosophy and theory of design; development of personal technique and expression in communicative media.

b. Technology: Further study of capabilities and limitations of building materials; shop testing of experimental structures; principles of special-purpose structural shapes; full integration of construction methods, systems, and services; principles of specifications.

c. Management: Legal aspects of practice; management and supervision of construction; client interviews and programming; project presentation techniques; professional internships.

Laboratory fee required. *Staff*

Architecture 499a, 499b. Preceptorship B Program

Selected students spend the entire year working and studying in the offices of their Preceptors.

Architecture 501a, 502b. Principles of Architecture (6-21-13, each sem.).

a. Design: Institutional and urban planning problems, high-rise buildings, landscape planning; design-theory seminars; basic design studies.

b. Technology: Comparative structural systems; basic methods of research; independent experimentation in materials and structures; seminars with allied consultants—estimators appraisers, contractors, insurance specialists, special equipment consultants.

c. Management: Office management and operation; purpose of professional organizations; registration laws and procedures; professional ethics; place of advanced study and travel in the development of the architect.

Laboratory fee required. *Staff*

Architecture 601a, 602b. (8-15-13, each sem.).

Independent investigations in architecture culminating in preparation and presentation of a master's thesis. Laboratory fee required.

Staff Specialists, University Staff

Art

(*See* pages 189-190)

Behavioral Sciences

Undergraduate Program. The major in behavioral science centers on a nucleus of courses in anthropology, psychology, and sociology. The student will ordinarily emphasize one of these three nuclear fields. Instruction in related fields such as political science, economics, biology, and history may be substituted with the approval of the adviser.

Students majoring in behavioral science will be required to take a total of ten semester-courses in anthropology, psychology, and sociology, of which eight must ordinarily be on the Junior and Senior level, courses numbered 300 or higher. With the approval of the major adviser, a maximum of two semester-courses numbered 300 or higher in related fields outside the nuclear fields may be included in the major.

Graduate Program. The Department of Psychology and the Department of Anthropology and Sociology have combined for an interdisciplinary graduate program in behavioral science. This program is designed to lead to the doctorate. One foreign language is required, and a second language may be required, in accord with the student's area of specialization. The doctorate will allow the student to specialize in either anthropology or sociology. In addition to the major emphasis on one of these disciplines, students will be expected to meet certain requirements in the other of these two disciplines and in psychology. The alternatives are therefore: (1) emphasis on anthropology, with minimal requirements in psychology and sociology, or (2) emphasis on sociology, with minimal requirements in anthropology and psychology. The minimum duration of the program is three years. Qualifying examinations testing ability to meet minimal requirements in all three disciplines must be passed not later than the end of the second year. Comprehensive examinations in the discipline being emphasized (either anthropology or sociology) must be passed before the student undertakes work on the doctoral dissertation. An important part of the student's training is involvement in ongoing research by members of the faculty. The master's degree will be

awarded only in unusual cases. The master's degree will require selected courses in major and related fields, as approved by an advisor, totaling 30 hours. One foreign language is required, a second foreign language is optional. A thesis is necessary.

BEHAVIORAL SCIENCE COURSES

Behavioral Science 500a, b. Social Thought and Social Theory (3-0-3, each sem.).

Critique and analysis of theories of social organization developed by several major social scientists (first semester). Consideration of logical and methodological problems of theory construction; discussion of differences between evaluative and explanatory models of society and an investigation of the different levels of theoretical generalization possible in social science (second semester). *Staff*

Behavioral Science 505. Independent Study and Tutorial (0-0-3 to 9). *Staff*

Behavioral Science 515b. Ethnological Theory (3-0-3).

A seminar presenting a survey and appraisal of major developments and trends of ethnological theory since the beginnings of anthropology as a systematic branch of study. *Staff*

Behavioral Science 520a. Theory and Problems of Underdeveloped Societies (3-0-3).

A study of the characteristics of traditional societies *Staff*

Behavioral Science 525b. Theory and Problems of Developing Societies (3-0-3).

A study of characteristics of developing societies. *Staff*

Behavioral Science 530a. Behavioral Science Research Methods and Techniques (3-0-3).

Introduction to research strategies of anthropology, sociology and social psychology. *Staff*

Behavioral Science 540b. Behavioral Science Research Methods and Techniques (3-0-3).

Specialized research techniques: interviews, questionnaires, projective techniques, tests, etc. *Staff*

Behavioral Science 550b. Seminar in Urban Affairs (3-0-3).

Seminar devoted to research concerned with ecological and cultural influences in urban areas. *Staff*

Certain undergraduate courses in psychology, anthropology, sociology, and linguistics will be recommended, depending on the background of individual students.

Inter-University African Studies Program

By arrangement with the University of Houston, Texas Southern University, and St. Thomas University in the field of African studies, graduate students interested in Africa, may attend courses and obtain credit at these other universities. Information of the courses offered can be obtained from the chairman of the Psychology Department at Rice.

Anthropology and Sociology

Professors Goodman, Hole, Norbeck, *Chairman*
Assistant Professors Gamst, Harwood, and Martin
Visiting Assistant Professor Sheldon
Instructors Hembree and Ingham
Lecturers Giles and Davidson

The *Undergraduate Major in Anthropology.* Students majoring in anthropology are required to take a total of ten semester-courses of anthropology, eight of which must be on the Junior and Senior level, courses numbered 300 or higher. Anthropology 200a and 201b are ordinarily required for all majors. Not more than twelve semester-courses in the major, including courses in the 200 series, are permitted. With the approval of the departmental adviser, a maximum of two semester-courses numbered 300 or higher in related subjects, including certain courses in biology, history, psychology, and sociology, may be substituted for courses in anthropology. Linguistics 401a and 402b are acceptable for credit toward the major in anthropology.

Graduate Work in Anthropology and Sociology. The Master of Arts and the Doctor of Philosophy in Behavioral Science are offered under an interdisciplinary program that combines instruction in anthropology, sociology, and psychology. See Behavioral Science, page 118.

ANTHROPOLOGY COURSES

Anthropology 200a. Physical Anthropology (3-0-3).

Human evolution, fossil man, human genetics, races of man and problems of race; the beginnings of culture. *Mr. Norbeck*

Anthropology 201b. Introductory Cultural Anthropology (3-0-3).

Major aspects of culture (social organization, economics, religion); cultural patterns and sociocultural change; late prehistory of man and the evolution of culture. *Mr. Gamst*

Anthropology 300a. The Evolution of Culture (3-0-3).

A consideration of theories and supporting data concerning the evolution of culture. Special attention is given to the manner of growth and change of tech nology, economic systems, social structure, and religion, and to interrelationships of these elements of culture. *Mr. Gamst*

Anthropology 301b. Primitive Religion (3-0-3).

Comparative survey of religion and magic; the relation of religion and magic to other aspects of culture, and their roles with respect to society and the individual. *Mr. Norbeck*

Anthropology 310a. World Ethnology (3-0-3).

A survey of selected non-Western societies which illustrate varying modes of adaptation to geographical and cultural environments. Not offered in 1968-69. *Mr. Ingham*

Anthropology 311b. North American Ethnology (3-0-3).

A general survey of native cultures north of Mexico. Intensive study of selected peoples in light of the processes of culture. Not offered in 1969. *Mr. Hole*

Anthropology 320a. Old World Prehistory (3-0-3).

The origin and development of human culture during the Pleistocene period; man's achievement of food production and the beginnings of literate civilizations in the Near East. *Staff*

Anthropology 321b. New World Prehistory (3-0-3).

Man's entry into the Americas; his dispersal with varied ecological adaptations over the continent; the attainment of civilized societies in Meso-America and Peru. Not offered in 1969. *Mr. Hole*

Anthropology 325a. Peoples and Cultures of Latin America (3-0-3).

A survey of native and European derived cultures of Mexico, Central America, and South America, including historical backgrounds and modern problems. *Mr. Ingham*

Anthropology 330a. Early Civilizations (3-0-3).

The growth and characteristics of civilization in Mesopotamia, Egypt, India, Meso-America, and Peru are examined historically and comparatively. Not offered in 1968-69. *Mr. Hole*

Anthropology 331b. Culture Contact (3-0-3).

Descriptions of intercultural contact are examined to determine conditions under which cultural change, assimilation, integration, interdependence, or exclusion may occur. Not offered in 1969. *Staff*

Anthropology 345b. Peasant Societies and Cultures (3-0-3).

Ethnological survey of origins and distribution of Old Word peasantries and study of representative modern groups emphasizing rural urban relations and cultural dynamics. *Mr. Ingham*

Anthropology 350a. Peoples and Cultures of the Middle East (3-0-3).

Ethnological study of peoples and cultures of the Middle East, emphasizing Arabic-speaking societies and including Turkey, Iran, and minority groups of the Arabic world. Not offered in 1968-69. *Mr. Gamst*

Anthropology 351b. Peoples and Cultures of Africa (3-0-3).

Ethnology of Africa, emphasizing the peoples and cultures of sub-Saharan Africa. *Mr. Gamst*

Anthropology 360a. Culture and Personality (3-0-3).

A consideration of theories, methods, and findings in the cross-cultural study of the relationships between personality and culture; mental health in cross-cultural perspective. *Mrs. Goodman*

Anthropology 380a. Peoples and Cultures of Asia (3-0-3).

Survey of the Far East, emphasizing traditional cultures of Siberia, China, Japan, Tibet, and Southeast Asia, and their relationships. *Mrs. Goodman*

Anthropology 381b. The Study of Cities (3-0-3).

Comparative study of cities in widely separated areas of the world, identifying constants and major variables of urban culture, ancient, recent, and modern. *Mrs. Goodman*

Anthropology 385b. History and Culture of Japan (3-0-3).

A general survey of Japanese culture from its beginnings that emphasizes social and other major cultural changes of modern times. Interpretations of the processes

of sociocultural change involved are presented in a context of anthropological theory that makes use of camparisons with circumstances in other societies and nations of the world. Offered in alternate years. To be taught in 1969.

Anthropology 390b. Value Systems (3-0-3).

Study of value categories; comparative study of systems of values, and their implications for behavior, in selected folk and sophisticated cultures. *Mrs. Goodman*

Anthropology 400a. Ethnological Theory (3-0-3).

A seminar presenting a survey and appraisal of major developments and trends of ethnological theory since the beginnings of anthropology as a systematic branch of study. Approval of instructor required for enrollment. *Staff*

Anthropology 401b. Kinship and Social Structure (3-0-3).

A seminar presenting an historical, analytic, and interpretive treatment of ethnological data and concepts concerned with kinship and the social structure of human societies. Approval of instructor required for enrollment. Not offered in 1969. *Mr. Norbeck*

Anthropology 404a, 405b. Independent Study (0-0-3, each sem.).

Directed reading and preparation of written papers on anthropological subjects not offered in the curriculum and advanced study of subjects on which courses are offered. Conducted for graduate students as tutorial courses with no formal class meetings. Students seeking admission must secure approval of the department. *Staff*

Anthropology 599b. Research and Thesis in Behavioral Science.

Research and thesis in partial fulfillment of the degree of Master of Arts in Behavioral Science.

Anthropology 699b. Research and Thesis in Behavioral Science.

Research and thesis in partial fulfillment of the degree of Doctor of Philosophy in Behavioral Science.

The Undergraduate Major in Sociology. The goals in sociology are to acquaint the student with the nature of group behavior, social relations, and in the broadest sense, the structure of society. Students majoring in sociology are required to take a total of ten semester-courses in sociology, including Sociology 200a, 201b, and 420b. In the summer between the Junior and Senior year, each student is encouraged to gain experience in a foreign culture, particularly a non-Western society. In the Senior year, each student will write a thesis representing a piece of original research.

SOCIOLOGY COURSES

Sociology 200a. Introduction to Sociology (3-0-3).

An introduction to the scientific study of society. The course will examine basic theories concerning the nature of society and the individual's relationship to his social world. *Mr. McCord*

Sociology 201b. American Social Problems (3-0-3).

An examination of the causes and treatment of certain American social problems: crime, alcoholism, mental disorder, and ethnic conflict. *Mr. McCord*

Sociology 300a. Social Stratification (3-0-3).

A study of the division of societies into classes, estates, and castes. Social mobility, the distribution of social power, and the relation of ethnic groups to class structure

prestige and esteem. The method of research into stratification. Analysis of studies of the American class system. *Staff*

Sociology 301b. American Ethnic Groups (3-0-3).

Survey of major ethnic groups of which the population of the U.S. is composed. Social, cultural, and religious factors. The processes of cooperation, conflict, and assimilation as they relate to nationality groups. Immigration as a factor in American society. *Staff*

Sociology 304a, 305b. Independent Study (0-0-3, each sem.)

Directed reading and preparation of written papers on sociological subjects not offered in the regular curriculum and advanced study of subjects on which courses are offered. Conducted as tutorial courses with no formal class meetings. Students seeking admission must secure approval of the department. *Staff*

Sociology 310a. Social Change (3-0-3).

A study of the processes of social change from the perspectives of leading theorists. Patterns and differential rates of change. Human motivations, political factors, policy making and planning in social development. Social change as a local and world phenomenon. *Staff*

Sociology 311b. Collective Behavior (3-0-3).

A study of the nature, origin, and development of social groups: crowds, mobs, publics, cults and sects; conditions of social unrest, collective excitement, and panic; public opinion, reform movements, fashions and fads; the origin and reorganization of institutions, values, and societies. *Staff*

Sociology 315a. Social Thought and Social theory, I (3-0-3).

Emphasis will be placed on the critique and analysis of theories of social organization developed by several major social scientists. *Mr. Harwood*

Sociology 316b. Social Thought and Social Theory, II (3-0-3).

Consideration of the logical and methodological problems of theory construction; discussion of differences between evaluative and explanatory models of society and an investigation of the different levels of theoretical generalization possible in social science. *Mr. Harwood*

Sociology 325a. Urban Social and Political Change (3-0-3).

This course will explore historical changes in the political organizations of American cities and the relationship of these changes to alterations in the ethnic, racial, and class composition of cities. *Mr. Harwood*

Sociology 330b. Social Philosophy (3-0-3).

A seminar devoted to an examination of issues in contemporary sociology, including those concerned with physologism, behaviorism, positivism, and historicism. *Staff*

Sociology 400b. Seminar on the Foundations of Social Thinking (3-0-3).

The development of sociological thought through the integration of contributions from biology, philosphy, anthropology, and other social sciences. Special emphasis is given to the culture concept, social values and social institutions, and the social process in relation to problems of social disorganization and adjustment. *Mr. Giles*

Sociology 404a, 405b. Independent Study (0-0-3, each sem.).

Directed reading and preparation of written papers on sociological subjects not offered in the regular curriculum and advanced study of subjects on which courses are offered. Conducted for graduate students as tutorial courses with no formal class meetings. Students seeking admission must secure approval of the department. *Staff*

Sociology 410a. Social Change in Developing Areas (3-0-3).

A seminar devoted to a consideration of the relation between social, political, and economic change in such nations as India, Egypt, Nigeria, and Indonesia. A critical review of basic theories. Approval of instructor required for enrollment. *Mr. McCord*

Sociology 415b. Industrial Social Structure and Culture (3-0-3).

This course will focus attention on the economic and political preconditions of Western industrial societies and attempt to give some understanding of the unique characteristics of modern industrial social organization and culture. *Mr. Harwood*

Sociology 419a. Communities (3-0-3).

An analysis of the structure, processes, and organization of contemporary towns and cities. The nature and varieties of community. Consideration is given to the phenomena of urbanism and of community cohesion. Methods and cases of community research. *Staff*

Sociology 420b. Field Methods (3-0-3).

Research projects in sociology undertaken by advanced students, singly or in teams, will serve as a focus for discussion of research methods. Approval of instructor required for enrollment. *Staff*

Sociology 425b. Political Sociology (3-0-3).

A seminar devoted to an examination of the social basis of political behavior. *Mr. Harwood*

Sociology 498a, 499b. Research and Thesis in Sociology (0-0-3, each sem.).

Research and thesis in partial fulfillment of the degree of Bachelor of Arts in Sociology. *Staff*

Sociology 599b. Research and Thesis in Behavioral Science.

Research and thesis in partial fulfillment of the degree of Bachelor of Arts in Behavioral Science.

Sociology 699b. Research and Thesis in Behavioral Science.

Research and thesis in partial fulfillment of the degree of Doctor of Philosophy in Behavioral Science.

Psychology

PROFESSORS HOWELL, HUDSON, PRICE-WILLIAMS, *Chairman,* AND WANN
ASSOCIATE PROFESSOR SCHUM
ASSISTANT PROFESSORS DUCHARME, MCGINNIS, AND RAMIREZ

Students planning to major in psychology should take two courses during the Sophomore year, Psychology 200a, 205b. Majors are expected to take ten semester-courses in addition. Psychology 325a, b and Psychology 340a, b are obligatory for majors. Psychology 200a and 305b are open to nonmajors.

COURSES

Psychology 200a. Survey of Psychology (3-0-3).

A survey of the fields of psychology and an introduction to its main theoretical issues. *Mr. Price-Williams*

Psychology 205b. Social Aspects of General Psychology (3-0-3).

An advanced extension of the work covered in the introductory course. Individual and social aspects of psychological processes in motivation, learning, perception, thought, and language. *Staff*

Psychology 305b. An Introduction to the Concepts and Techniques of Social Psychology (3-0-3).

Social processes and relations between individuals and groups. Prerequisite: Psychology 200a and 205b. *Staff*

Psychology 325a. Statistics and Research Design (3-0-3).

The primary purpose of this course is to provide the background in probability theory necessary for an understanding of descriptive and inferential statistics. Among the topics discussed are: the language of sets as applied to probability theory, probability as a measure, discrete and continuous random variables, some common probability distributions, mathematical expectation, and descriptive indices of central tendency, variability, and association. Also discussed are research design and measurement problems peculiar to the behavioral sciences. Prerequisite: Psychology 200a and 205b. *Mr. Schum*

Psychology 325b. Advanced Statistics and Research Design (3-0-3).

This course provides an introduction to the inferential techniques of hypothesis testing and point and interval estimation. Special emphasis is placed upon analysis of variance techniques. Also discussed are problems in regression and correlation. Prerequisite: Psychology 200a and 205b, 325a. *Mr. Schum*

Psychology 330a. Differential Psychology (3-0-3).

This course is designed to familiarize the student with the techniques for measuring individual differences. Critical reviews will be made of various thories of individual differences in intelligence and personality. Prerequisite: Psychology 200a and 205b. *Mr. Wann*

Psychology 330b. Personality Theory (3-0-3).

An introduction to the concepts and techniques of personality study. A continuation of Psychology 330a, which is a prerequisite. *Mr. Wann*

Psychology 340a. Experimental Psychology (3-4-4).

An introduction to laboratory methods of research in the areas of sensation, perception, and learning. Prerequisite; Psychology 200a and 201b. *Mr. McGinnis*

Psychology 340b. Advanced Experimental Psychology (3-4-4).

An advanced course in psychological research using humans and animals with particular reference to psychological theory. Emphasis is placed upon the design and execution by the student of exploratory studies. Prerequisite: Psychology 200a and 205b, 340a. *Mr. McGinnis*

Psychology 351a. Sensory Psychology (3-0-3).

Phenomena, methods, and theory in sensory psychology. Special emphasis on vision and audition. Prerequisite: Psychology 200a and 205b. *Mr. Schum*

Psychology 361a. Contemporary Issues in Psychological Research (3-0-3).

A survey of (a) major viewpoints concerning the planning, design, and execution of psychological research, (b) major substantive areas of research, and (c) ethics and values in research. Prerequisite: Psychology 200a and 205b. *Mr. Willems*

Psychology 400a. Learning (3-0-3).

Selected topics in learning theory and supporting data. Emphasis on newer mathematical models and related attempts to account for human and animal learning phenomena in a quantitative manner. Approval of instructor required for enrollment. *Mr. McGinnis*

Psychology 400b. Advanced General Psychology (3-0-3).

An attempt to derive a set of basic principles of psychology as a unified discipline. Emphasis will be on the reconciliation of conflicting theoretical orientations. Approval of instructor required for enrollment. *Messrs. Hudson and Price-Williams*

Psychology 410a. Development Social Psychology (3-0-3).

The course presents three major topics: adolescence, comparative social psychology, and theories and problems of social psychology. The first semester is designed to acquaint the student, from the point of view of adolescence, with the physical, social, and emotional processes that go into the making of an adult. Approval of instructor required for enrollment. *Mr. Wann*

Psychology 410b. Developmental Social Psychology (3-0-3).

The second semester is a continuation of the above topics, giving greater emphasis to social processes. These are viewed from the vantage point of comparative social psychology and the wide varieties of behaviors possible for human beings and from the points of view provided by alternative theories. Approval of instructor required for enrollment. *Mr. Wann*

Psychology 415a. History and Theories of Psychology (3-0-3).

A review of the development of Western scientific psychology and the emergence of theoretical systems. Approval of instructor required for enrollment. *Mr. Hudson*

Psychology 452b. Engineering Psychology (3-0-3).

A survey of research on those aspects of human behavior which are relevant to the design of man machine systems. The course includes discussions of the capabilities and limitations of man as a sensor and interpreter of information-carrying signals, as a processor of discrete and continuous information, and as a decision-maker. Also discussed are applications of statistical decision theory, information theory, and servo-mechanism theory in the study of human behavior. Approval of instructor required for enrollment. *Mr. Schum*

Psychology 462b. Psychological Ecology (3-0-3).

A complement to Experimental Psychology and supplement to Contemporary Issues in Psychological Research, this course will survey the rationale, research problems, and methods for studying behavior in its natural, everyday habitat. Approval of instructor required for enrollment. *Mr. Willems*

Psychology 490a, b. Independent Study and Research (3-0-3, each sem.).

Approval of instructor required for enrollment. *Staff*

Psychology 599a, b. Research and Thesis in Behavioral Science (Variable credit.)

Research and thesis in partial fulfillment of the degree of Doctor of Philosophy in Behavioral Science. *Staff*

Psychology 699a, b. Research and Thesis in Behavioral Science (Variable credit).

Research and thesis in partial fulfillment of the degree of Doctor of Philosophy in Behavioral Science. *Staff*

Biology

Professors Awapara, Read, *Chairman,* Storck, Subtelny, Talmage, and J. B. Walker
Associate Professors Campbell, Elbein, F. Fisher, Karakashian, Philpott, and Ward
Assistant Professors Ansevin, Eisenberg, and J. Palka
Lecturer Pulley

Undergraduate Program. A major in biology may be taken in the humanities (academic) or the science-engineering program (*see* pages 53-59). The science-engineering program is strongly recommended. All majors are required to take introductory courses in physics and mathematics, Chemistry 120a, Biology 201a,b, and organic chemistry. It is recommended that majors who plan to enter graduate school take at least two years of German. In addition to Biology 201a,b, the department requires satisfactory completion of Biology 301a,b, Biology 303a, 304a, 305b, and at least four semesters of additional advanced work in biology.

Biochemistry Major. An interdepartmental major in biochemistry is offered in conjunction with the Department of Chemistry. The program of students wishing to elect this major must be approved by both departments.

Special Projects in Biology: Qualified biology majors are encouraged to undertake a research problem under the supervision of a faculty adviser. Such students may substitute Biology 400a,b for two advanced semester-courses during the Senior year. Funds are also available to support summer research by qualified undergraduate students. For more complete information concerning these programs, consult with members of the department staff.

Graduate Program. Open to qualified applicants who hold a bachelor's degree or equivalent in one of the natural sciences or engineering. Prospective graduate students are advised to take the Graduate Record Examination before applying, or as soon thereafter as practicable.

The following areas of specialization are currently offered in biology: biochemistry, cell biology, general physiology, genetics, invertebrate and vertebrate physiology, microbiology, symbiosis and parasitism, and environmental biology.

Program for the Degree of Doctor of Philosophy:

(a) Usually four or more years of graduate study with at least the last two years at Rice University.
(b) At least thirty-six semester-hours of graduate courses in biologi-

cal and related sciences other than thesis work, of which at least three must be taken at Rice University.

(c) Completion of an original investigation worthy of publication in a recognized scientific journal, and the submission of a doctoral thesis as described on page 102.

(d) Satisfactory evidence of competence in a foreign language to be specified by the department.

(e) Satisfactory performance in a written and/or oral examination administered by the department.

(f) An oral examination in defense of the thesis during the last year of residence.

The Degree of Master of Arts. The degree of Master of Arts may be obtained after two years of graduate study upon the successful completion of the language requirement, twenty-four semester-hours of graduate courses, satisfactory work in a written examination, and the acceptance of a thesis embodying the results of original investigation, in defense of which an oral examination is taken. The taking of this degree is not required as a prerequisite for the degree of Doctor of Philosophy and may be omitted with the approval of the departmental staff.

Assistantships. Financial assistance in the form of graduate fellowships, predoctoral fellowships, research assistantships, and scholarships is available. All graduate students in biology are expected to engage in laboratory instruction regardless of appointment. Graduate students are assigned to different courses from year to year to obtain the maximum benefit from this phase of training.

COURSES

A. Courses for Students Not Concentrating in Biology

The following course is offered for those students needing a preliminary course in the field. This course is not applicable to a major in biology.

Biology 100a, b. General Biology (3-3-4, each sem.).

In this terminal course emphasis will be placed on the methods of science, the mechanisms of growth, metabolism, and heredity, and the concept of organic evolution. The laboratory work will include demonstrations and selected experimentation. *Staff*

B. Biology Courses for Those Concentrating in Biology

Biology 201a, b. Introduction to Biology (3-3-4, each sem.).

A general introductory course dealing with the basic principles of biology. The first semester will be devoted mainly to subcellular phenomena, followed by consideration of cell organization, differentiation, organ and organismal function, population phenomena, and evolution. This course is a prerequisite for advanced courses in biology. Concurrent registration in Chemistry 200a,b is recommended. Prerequisite: Chemistry 120a,b or equivalent. *Staff*

Biology 301a, b. Organismal Biology (3-3-4, each sem.).

The evolution, systematics, and zoogeography of the invertebrates and vertebrates, with a consideration of their comparative morphology, physiology, and behavior as related to adaptation for aquatic, terrestrial, and aerial habitats. This course is required for biology majors. Prerequisite: Biology 201a,b. Laboratory fee required. *Staff*

Biology 303a. Introduction to Biological Chemistry (3-0-3).

An introduction to the chemistry, biodegradation and biosynthesis of cell constituents. Mechanisms of enzyme-catalyzed reactions and energy yielding reactions in the cell are discussed. Prerequisite: Organic Chemistry (Chem. 200). *Mr. Awapara*

Biology 304a. Laboratory in Biological Chemistry (0-3-1).

This laboratory introduces the student to some simple procedures used in the extraction of proteins, nucleic acids and polysaccharides from biological materials. Also introduces the student to the analysis of enzyme catalyzed reactions and their kinetics. Required for biology majors. *Mr. Awapara*

Biology 305b. Cell Physiology (3-3-4).

The detailed analysis of cell function. Required for biology majors. Prerequisites: Chemistry 200a,b.; Biology 303a, and general physics. Laboratory fee required. *Mr. Palka*

Biology 360a. Marine Biology (3-3-4).

A study of the marine and estuarine environments with particular attention to the local fauna. Laboratory will include weekend field trips. Class is limited to fifteen students. Prerequisite: A course in invertebrate zoology or invertebrate paleontology. Laboratory fee required. *Mr. Pulley*

Biology 400a, b. Special Problems and Honors Work (2-6-4, each sem.).

Open only to Senior biology majors and with permission of the chairman of the department. For use primarily in honors programs. *Staff*

Biology 405b. Plant Physiology (3-3-4).

The cellular and organismal physiology of selected plant types. Attention will be given to nutrition, metabolism, growth, and physiological interactions with environment. Prerequisite: Biology 201, 301a,b, 303a, 305b. Laboratory fee required. *Mr. Ward*

Biology 410b. Genetics (3-3-4).

Topics considered include the composition and organization of the genetic material, recombination and mutation, function of the gene, and the role of genetic variability in evolving populations. The complementary roles of genetic and biochemical methodologies are stressed. *Mr. Karakashian*

Biology 415a. Botany (3-3-4).

A comparative study of plants as viewed through physiology and evolution. Prerequisite: Biology 201a,b. Laboratory fee required. *Mr. Pulley*

Biology 420a. Parasitism and Symbiosis (3-3-4).

An introduction to the biology of symbiosis, with special emphasis on the physicochemical relationships between organisms. Illustrative examples demonstrating principles are drawn from the plant or animal kingdoms. Prerequisite: Biology 301a,b and 303a, 305b. Laboratory fee required. *Mr. Read*

Biology 425a. Concepts of Nervous System Functions (3-3-4).

A variety of approaches to the study of nervous systems is developed, ranging from studies of single neurons to the behavior of whole animals. There is strong emphasis on laboratory work. Prerequisite: Consent of instructor; understanding of resting and action potentials at the level presented in Biology 305b is assumed. Limited to 12 students; may be taken for graduate credit. *Mr. Palka*

Biology 430b. Population Ecology (3-3-4).

A theoretical and experimental approach to the study of populations. Stress will be placed on quantitative approaches to current concepts and problems. Topics to be considered include intra- and interspecific relationships and community structure. Prerequisites: Biology 301a,b, 303a, 305b. *Mr. Eisenberg*

Biology 440a. Comparative Biochemistry and Physiology (3-3-4).

A consideration of the concept of biochemical unity as it relates to the origin of life and the establishment of metabolism and information transfer. Subsequent evolution and biological diversity are considered as logical extensions of this concept. Weekly student seminars are held on current and/or pertinent literature. Laboratory consists of special projects designed to illustrate techniques used in the study of invertebrate biochemistry. Prerequisite: Biology 303a, 305b. Laboratory fee required. *Mr. Campbell*

Biology 445a. Comparative Vertebrate Physiology (3-3-4).

Studies of the physiology of organ systems. Homeostatic capacities of individual organ systems with their comparative function in various vertebrate groups will be emphasized. Prerequisite: Biology 301a,b and 303a. Permission of instructor. Laboratory fee required. *Staff*

Biology 450b. Developmental Biology (3-3-4).

An analysis of developmental processes in the animal organism from fertilization to the elaboration of its final form. Emphasis will be placed on induction and cell differentiation. Organogenesis, metamorphosis, regeneration, and other developmental phenomena will be discussed. The laboratory work will concern observation and experimental analysis of development in amphibian and avian embryos. Laboratory fee required. *Mrs. Ansevin*

Biology 460b. Advanced Biochemistry (3-0-3).

A detailed study of the integrated networks of enzymatic reactions characteristic of living cells of man and microbes. Emphasis is placed on the nature and characteristics of enzymatic catalysis, pathways involved in the biosynthesis of cell constituents, and mechanisms responsible for coordinating the rates of hundreds of simultaneous enzymatic reactions. Prerequisite: Biology 303a or consent of instructor. *Mr. Walker*

Biology 465b. Advanced Biochemistry Laboratory (1-8-3).

A laboratory course emphasizing procedures involved in answering specific biochemical questions. Students are assigned research projects after they have become acquainted with general characteristics of enzyme-catalyzed reactions. Laboratory fee required. Prerequisite: consent of instructor. *Mr. Walker*

Biology 470a. General Microbiology (3-3-4).

A study of microorganisms, including Protozoa, algae, fungi, bacteria, and viruses. Special attention will be given to the bacteria. Lectures will be concerned with evolution, classification, growth, nutrition, and metabolism. Prerequisites: Biology 301a,b and 303a, 305b. Laboratory fee required. *Mr. Elbein*

Biology 475a. Cells and Tissues (3-3-4).

Study of the morphology and function of cell components, cells, and tissues, as revealed by light and electron microscopy and associated histo- and cytochemical methods. Laboratory work in histology and histochemistry. Prerequisite: Biology 303a, 305b, or its equivalent. Laboratory fee is required. *Mr. Philpott*

Biology 480a. Endocrinology (3-3-4).

Study of the primary endocrine glands of mammals and their relationships to the physiological homeostasis of the mammal. While emphasis is placed on the function, morphology, and interrelationships of the glands of internal secretion of mammals, the comparative anatomy and evolution of these glands in the vertebrates is discussed. Laboratory work is restricted primarily to histological study of

the glands, surgical procedures, and simple experiments demonstrating hyposecretion. Prerequisite: Biology 303a. Laboratory fee required. *Mr. Talmage*

Biology 500. Biology Seminar (1-0-2).

Held weekly to hear papers on current research by members of the staff, visiting investigators, and advanced graduate students. Attendance by graduate students in biology is required. Visitors and undergraduates are invited. *Staff*

Biology 509. Biology of Macromolecules (3-3-4).

Study of structure, metabolism and function of the nucleic acids and certain other cell molecular components. *Mr. Storck*

Biology 510a, b. Topics in Biochemistry (3-0-3).

Messrs. Awapara and Walker

Biology 514a. Biosynthesis of Natural Products (3-0-3).

A study of mechanisms of biosynthesis of complex substances of current interest in biology. Prerequisite: Biology 460b or consent of instructor. *Mr. Walker*

Biology 516b. Proteins and Amino Acids (3-0-3).

A study of the metabolism of proteins and amino acids. Some attention will be given to methods of protein isolation and characterization. Prerequisite: Biology 460b. *Mr. Awapara*

Biology 520. Advanced Cell Physiology (3-0-3).

A seminar on current literature and research in cell physiology. Prerequisite: Consent of instructor. *Mr. Campbell*

Biology 521. Advanced Comparative Biochemistry and Physiology (3-0-3).

Offered in 1967-68 and in alternate years thereafter. A seminar on current literature and research in comparative biochemistry and biochemical evolution. Prerequisite: Biology 440b and graduate standing. *Mr. Campbell*

Biology 540. Cell Biology (2-6-4).

Instruction in methods for studying cells and cell phenomena and in interpretation of observations. Laboratory work will involve the practice and application of techniques to cell biology. Seminar work will focus on recent work on morphology, function, and biochemistry of cells. Prerequisite: Biology 303a, 305b (or equivalent) and Biology 475a. *Mr. Philpott*

Biology 541. Topics in Cell Biology (3-0-3).

Mr. Philpott

Biology 545a. Seminar in Tissue Culture (2-0-2).

Review of significant applications of tissue culture methods in biological research. *Mrs. Ansevin*

Biology 546a. Tissue Culture Techniques (0-6-2).

The laboratory course will offer practical experience with several basic tissue culture techniques and work on a special project of special interest to the student. Prerequisite: Consent of instructor and concurrent registration in Biology 545. *Mrs. Ansevin*

Biology 550. Topics in Microbiology (3-0-3).

Mr. Elbein

Biology 560. Physiology of Parasitism (3-0-3).

Conferences, student reports, and laboratory work on the physiology of parasites and the functional relationships of hosts and parasites. Attention will be given to

growth, metabolism, nutrition, and physiological evolution of parasites, with emphasis on comparative aspects. The basis of pathology and disease will be treated as a series of physiochemical problems, with examples drawn from the animal or plant kingdom. *Mr. Read*

Biology 561. Topics in Symbiology (3-0-3).

Offered in alternate years with Biology 560. *Mr. Read*

Biology 570. Arthropod Physiology (3-0-3).

Readings, conferences, and student reports on current literature concerned with the physiology of arthropods. Special emphasis will be placed on the insects. *Mr. Fisher*

Biology 571. Invertebrate Endocrinology (3-0-3).

Offered in alternate years with Biology 570. Consideration of current literature dealing with endocrine mechanisms in invertebrates. *Mr. Fisher*

Biology 580. Seminar in Endocrinology I (3-0-3).

The thyroid, pancreas, adrenals, and the relationships of hormones to carbohydrate metabolism are studied. Reading seminar on current literature in endocrinology. *Mr. Talmage*

Biology 581. Seminar in Endocrinology II (3-0-3).

The parathyroids, the pituitary, and the physiology of reproduction. Readings, conferences, and laboratory work. Includes also a weekly seminar on current literature in endocrinology. *Mr. Talmage*

Biology 590b. Instrumental Methods in Biology (3-4-4).

The basic theory and operation of modern instruments used in the quantitative study of living matter at the molecular, cellular, and organismal levels. Emphasis will be placed on methods having wide application, such as use of radioactive and stable isotopes, spectrophotometry, sedimentation, diffusion, viscosity, bioelectrical measurement, and electrophoresis. Attention will be given to limitations of methods and significance of the results obtainable. Prerequisites: At least one previous course in biology, chemistry, mathematics, and physics. Laboratory fee required. *Mr. Storck and Mr. Talmage*

Biology 599. Topics in Genetics (3-0-3).

Study of current literature in the broad areas of chemical genetics, microbial genetics, protein synthesis, differentiation, and mutation. It is held in collaboration with geneticists from other universities in Houston. *Mr. Karakashian*

Biology 600. Graduate Research.

Staff

Business Administration

(*See* pages 144-151)

Chemical Engineering

(*See* pages 157-161)

Chemistry

Professors Curl, Franklin, Kilpatrick, E. S. Lewis, Margrave, *Chairman*, Pitzer, Richter, Salsburg, Sass, and Turner
Assistant Professors Brooks, Cantrell, Gansow, Glass, Haug, Hayes, Magid, and Stevens

The Undergraduate Program. Undergraduates electing chemistry as a major are expected to satisfy the requirements of the science-engineering program set forth on pages 56-59. In general they will take Chemistry 200a,b in the Sophomore year in place of one of the specified electives. It is desirable for chemistry majors who seek admission to graduate school, but who do not possess advanced high school language credits, to take two years of German and one year of either French or Russian. The department further requires satisfactory completion of the following courses:

Junior Year

Chemistry 310a,b
Chemistry 400a and Chemistry 401a
Chemistry 470b
Mathematics 300a,b

Senior Year

Chemistry 460

Three semesters of approved advanced course work in chemistry. Superior students may substitute undergraduate research (Chemistry 490a, b) for one or two semesters of classroom instruction.

Interdepartmental Majors. Interdepartmental majors are offered in biochemistry and chemical physics by the Department of Chemistry in conjunction with the Department of Biology and the Department of Physics, respectively. Students wishing to elect either of these majors must be approved both by the Department of Chemistry and the other department concerned.

The Graduate Program. A student who has completed work equivalent to that required for the bachelor's degree in chemistry offered at Rice University may be admitted to graduate standing. Preference is normally given to applicants who earn high scores on the Graduate Record Examination, including the advanced test in chemistry (*see* page 101). A minimum of one year of graduate study is required for the degree of Master of Arts and at least two years for the degree of Doctor of Philosophy.

A candidate for the degree of Master of Arts is required to demonstrate a reading knowledge of scientific German, French, or Russian. He must complete six semesters of course work, present in a thesis the results of a program of research approved by the department, and pass a final oral examination.

To be recommended for the degree of Doctor of Philosophy, the student must complete for publication a thesis which represents a distinctly original and significant contribution to the field of chemistry. He must possess a reading knowledge of scientific German and of scientific French or Russian as a second language. The candidate must further have acquired through course work and independent study a broad fundamental knowledge of chemistry in addition to those areas of the subject encompassed by his own research interests. Cumulative examinations for the Ph.D. degree are given periodically and a final oral examination on the thesis is required for all candidates.

COURSES

Chemistry 120a, b. Introductory and Analytical Chemistry (3-3-4, each sem.).

A general introductory course dealing with the basic phenomena and principles of chemistry. The laboratory work in the first semester includes volumetric and gravimetric methods of quantitative analysis. The second deals with the fundamentals and methods of qualitative analysis. The course is required of science engineering students, and is also open to academic majors. Prerequisite: High school chemistry. Laboratory fee required.

Chemistry 200a, b. Organic Chemistry 3-4-4, each sem.).

The course is designed to give a thorough survey of aliphatic and aromatic chemistry with an introduction to the heterocyclic compounds, and to present the theories relating to their structure and reactions. The course is divided into two sections. One section is intended primarily for chemistry majors and those who plan further organic chemistry courses, the other is especially appropriate for premedical students.

Chemistry 310a, b. Physical Chemistry (3-4-4, each sem.).

A quantitative study of theoretical and physical chemistry with emphasis on the principles of thermodynamics, statistical mechanics, and quantum mechanics. Among the topics included are atomic and molecular structure, equilibria, electrochemistry, kinetics, and theory of solutions. The laboratory work consists of one four-hour period a week. Prerequisites: Mathematics 200a,b and Physics 210a,b.

Chemistry 400a. Advanced Organic Chemistry (3-0-3).

The course develops, in detail, the concepts of modern organic chemistry. A major portion is devoted to reactions of synthetic importance. Chemistry majors normally take this course in the Junior year. Prerequisite: Chemistry 200a,b.

Chemistry 401a. Advanced Organic Laboratory (0-8-2).

A laboratory course covering the techniques of modern organic chemistry. This course is designed to accompany Chemistry 400a. Prerequisite: Chemistry 200a,b. Laboratory fee required.

Chemistry 420b. Statistical Thermodynamics (3-0-3).

A development of the equilibrium theory of statistical mechanics. Applications to imperfect gas theory and the calculation of thermodynamic properties of molecules are given special attention. Prerequisites: Chemistry 450a, Mathematics 300a,b, and Physics 210a,b.

Chemistry 430a. Quantum Chemistry (3-0-3).

This course is devoted to a discussion of valence theory and to a consideration of structure and reactivity based upon simple quantum mechanical considerations.

Chemistry 445b. Physical-Organic Chemistry (3-0-3).

In this course, the student develops an understanding of the process by which the detailed mechanisms of organic reactions are elucidated. Prerequisite: Chemistry 310a,b, Chemistry 400a.

Chemistry 450a. Advanced Thermodynamics (3-0-3).

Relation of heat and work to chemical and physical systems. A consideration of free energy, entropy, and other thermodynamic functions as applied to equilibria. Special attention to the treatment of solutions.

Chemistry 460. Special Topics in Inorganic Chemistry (3-0-3).

This course will normally be taken by chemistry majors in the Senior year. Prerequisite: Chemistry 310a.

Chemistry 470b. Instrumental Methods (3-8-5).

A required course for Junior chemistry majors. Special emphasis is given to the principles and applications of modern instrumental methods in the areas of inorganic, organic, and physical chemistry. Laboratory fee required. Prerequisite: Chemistry 310a.

Chemistry 480. Chemistry of Natural Products (3-0-3).

A study of important types of naturally occurring substances of current interest in chemistry and biology. Prerequisite: Chemistry 400a.

Chemistry 490a, b. Special Study and Research for Undergraduates (Credit to be determined).

Open only to chemistry majors with superior records, and with the permission of the chairman of the department. Laboratory fee required.

Chemistry 500a, b. Graduate Research (Credit to be determined).

Chemistry 505a, b. Advanced Physical Chemistry (4-0-4, each sem.).

An intensive review of general physical chemistry with emphasis on independent work by the student. A course designed primarily for first-yar graduate students.

Chemistry 510a, b. Chemistry of the Steroids (3-0-3, each sem.).

A consideration of the reactions and stereochemistry of the steroids, including a discussion of the physiological importance of these compounds. Not offered in 1967-68.

Chemistry 520a, b. Kinetics of Reactions of Gases (3-0-3, each sem.).

A treatment from both theoretical and empirical considerations of chemical reactions in gases, including some studies of fast reactions catalyzed by solids. Prerequisite: Chemistry 505a,b or equivalent. Not offered in 1967-68.

Chemistry 530a. Chemistry of Gaseous Ions (2-0-2).

Prerequisite: Chemistry 505a,b.

Chemistry 540-544a, b. Special Topics in Organic Chemistry (3-0-3, each sem.).

Chemistry 550a. Reaction Kinetics and Mechanisms in Solutions (3-0-3).

A consideration of the rates of reactions with emphasis on homogeneous kinetics as a tool in the study of reaction mechanisms. Prerequisite: Chemistry 400a. Not offered in 1967-68.

Chemistry 560a, b. Advanced Organic Chemistry (3-0-3, each sem.).

The course deals with organic reaction mechanisms, modern structure theory

and synthetically important reactions. It is designed primarily for first-year graduate students.

Chemistry 563. Introduction to the Solid State (3-0-3).

This course will provide an introduction to the fundamental concepts about crystalline solids, and provide the basic preparation for further courses in the sequence Chemistry 564-567. It will consist of the following: a brief review of Quantum Mechanics and Statistical Mechanics, a discussion of crystal structure, a study of the diffraction of waves by lattices and an introduction to the concept of the reciprocal lattice, classical and quantum-mechanical descriptions of lattice vibrations and the thermal properties of insulators, and the properties of electrons in solids including free-electron and band-theoretical approaches. Prerequisites: An introductory background in wave mechanics and statistical mechanics, and concurrent enrollment in a graduate level quantum mechanics course is assumed. Also listed under same number in Departments of Electrical Engineering, Mechanical Engineering and Physics.

Chemistry 564. Electron Transport and Superconductivity (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow Chemistry 563. It will consider various aspects of electron transport, primarily from a microscopic viewpoint. Among topics to be covered will be various contributions to electron scattering and some techniques for measuring the Fermi Surface. In addition, an introduction to superconductivity will be presented. Prerequisite: Chemistry 563 or equivalent. Also listed under same number in Departments of Electrical Engineering, Mechanical Engineering and Physics.

Chemistry 565. Dielectric and Optical Properties of Matter (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow Chemistry 563. Topics included are: polarization and the static model of a dielectric medium in an electric field; extension of the above model to the dynamic case and dielectric dispersion in solids; Raman and Brillouin scattering; Optical spectra of solids; stimulated effects with applications to lasers; the dynamics of the nonlinear interaction between radiation and matter. Prerequisites: Chemistry 563 or equivalent. Also listed under same number in Departments of Electrical Engineering, Mechanical Engineering and Physics.

Chemistry 566. Imperfections and Mechanical Properties (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow Chemistry 563. Point defects in crystals, geometrical description of dislocations and the mathematical theory of lattice imperfections will be discussed. Non-thermal generation of point defects, physical observation of defects in crystals and special properties of lattice imperfections in metallic, ionic and homopolar crystals will be covered. How lattice imperfections in ionic, metallic and homopolar crystals affect certain physical properties of these crystals will be developed. The effects of lattice defects, particularly dislocations, upon the mechanical properties of crystals will be discussed. Prerequisites: Chemistry 563, or equivalent. Also listed under same number in Departments of Electrical Engineering, Mechanical Engineering and Physics.

Chemistry 567. Magnetism and Magnetic Resonance (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow Chemistry 563. The basis of the magnetic properties of solids will be discussed. This will include diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, and ferrimagnetism. The phenomenon of magnetic resonance will be studied. This will include nuclear magnetic resonance, electron paramagnetic resonance, and ferromagnetic resonance. The emphasis will be on the atomic origin of magnetism and on a description of the elementary excitations of ordered magnetic materials. Prerequisite: Chemistry 563 or equivalent. Also listed under same number in Departments of Electrical Engineering, Mechanical Engineering and Physics.

Chemistry 570a. Spectral Methods in Organic Chemistry (3-0-3).

The application of infrared, ultraviolet, and nuclear magnetic resonance spectroscopy to organic chemistry. Prerequisite: Chemistry 400a.

Chemistry 580a. Special Topics in Alkaloid Chemistry (3-0-3).

A consideration of the chemistry of selected groups of alkaloids. Not offered in 1966-67.

Chemistry 590a, b. Advanced Topics in Physical and Theoretical Chemistry (3-0-3, each sem.).

Chemistry 610a. High Temperature Chemistry (3-0-3).

A study of the techniques for generation and measurement of high temperatures and of the nature of high-temperature phenomena utilizing the principles of thermodynamics and quantum mechanics and modern experimental tools. Special attention is devoted to the characterization of high-temperature vapors, to gas-solid interactions, and to plasma phenomena.

Chemistry 640a. Chemistry of the Terpenes (3-0-3).

Not offered in 1967-68.

Chemistry 650a, b. Quantum Mechanics (3-0-3, each sem.).

A study of simple mechanical systems from the point of view of wave mechanics with application of these concepts to the chemical bond. Consideration of the energy states of polyatomic molecules. Prerequisite: Mathematics 300a,b or 310a,b.

Chemistry 660a. X-ray Crystal Structure Analysis (3-0-3).

A course in X-ray analysis including experimental methods, symmetry and space groups, dynamic theory of X-ray diffraction, Fourier and Patterson methods, modification functions, and order-disorder phenomena. Prerequisite: Chemistry 505a,b. Not offered in 1967-68.

Chemistry 700. Summer Graduate Research

Civil Engineering

(*See* pages 161-167)

Classics, Italian, Portuguese, Russian, and Spanish

Professor Levin
Associate Professors Castañeda, *Chairman,* Jitkoff and Leal de Martínez
Assistant Professors Lendínez, Skarginsky, and Urrutibeheity
Instructors Charles and Green
Lecturer Moore

Work is offered in Greek, Latin, Italian, Portuguese, Russian, and Spanish. Undergraduate majors are presently offered in Classical Studies and Spanish.

A fully equipped language laboratory is now in operation, and laboratory work is required of students in the beginning classes in all the modern languages.

Qualified upperclassmen may engage in independent work at the discretion of the department.

CLASSICS

Professor Levin
Instructor Charles
Lecturer Moore

Requirements for an Undergraduate Major in Classical Studies. A major in Classical Studies is presently offered with the cooperation of the Departments of History and Fine Arts. The overall major requirement is distributed between classical languages and literature (at least thirty semester-hours, equal to five year-courses, of which twenty-four hours, equal to four year-courses, must be at the 300 level or above) and relevant courses in fine arts, history, humanities, and philosophy. Preparation to insure an adequate reading and speaking knowledge of at least one modern foreign language is very strongly urged. All prospective programs for individuals majoring in Classical Studies are to be drawm up in consultation with the members of the Classics staff.

COURSES

Greek 100a, b. First-Year Greek (3-0-3, each sem.).

A course designed to develop as rapidly as possible an ability to read simple Greek prose: study of grammar, forms, and vocabulary is combined with practice in reading. *Mr. Charles*

Greek 200a, b. Intermediate Greek (3-0-3, each sem.).

The course is designed to broaden the skills acquired in Greek 100 through a close study of readings which may include a dialogue of Plato, a tragedy, or selections from Homer. *Mr. Levin*

Greek 300a. Greek poetry (3-0-3, each sem.).

A selection will be made from the writings of two or more Greek poets, exclusive of Homer. Prerequisite: Greek 200a,b or equivalent. *Staff*

Greek 300b. Greek Prose (3-0-3, each sem.).

Readings will be selected from the work of prose authors not already encountered in lower-level courses. Prerequisite: same as for Greek 300a. *Staff*

Latin 100a, b. First-Year Latin (3-0-3, each sem.).

Designed for students who have had no previous acquaintance with the Latin language. The first semester will be given over to grammatical and syntactic study. Selections from several Roman authors will be read during the second semester. *Mrs. Moore*

Latin 200a, b. Intermediate Latin (3-0-3, each sem.).

A course designed for students who enter with two or three years of high school Latin as well as for those who have successfully completed Latin 100a,b. Rapid review of forms and syntax will be followed by reading of representative selections from Latin prose and poetry. *Staff*

Latin 300a. Cicero (3-0-3).

Several works of Cicero will be read. There will be discussion also of related literary and historical topics. Prerequisite: Latin 200a,b or three or four years of high school Latin. *Mr. Charles*

Latin 300b. Catullus and Horace (3-0-3).

A study of the development of Latin lyric poetry in Catullus and the *Odes* and *Epodes* of Horace. Consideration will be given to their Greek predecessors, to the Roman age that they mirror, and to the standards by which their work may be criticized. *Mr. Levin*

Latin 410a. Tacitus (3-0-3).

Readings in the *Annals* of Tacitus and discussion of some of the historical problems of the region of Tiberius. Offered in alternate years: will be given in 1967-68. Prerequisite: Latin 300 a and b or equivalent. *Mr. Levin*

Latin 410b. Lucretius (3-0-3).

Readings in the *De Rerum Natura* and discussion of literary and philosophical topics. Offered in alternate years: will be given in 1969-70. Prerequisite: Latin 300 a and b or equivalent. *Mr. Charles*

Latin 420a. Elegiac Poetry (3-0-3).

Readings and discussion of a representative selection of poems by Catullus, Tibullus, Propertius, and Ovid. Offered in alternate years: will be given in 1968-69. Prerequisite: Latin 300 a and b or equivalent. *Mr. Levin*

Latin 420b. Satire (3-0-3).

Readings and discussion of a representative selection of the work of the Roman satirists, both in prose and in verse. Offered in alternate years: will be given in 1968-69. Prerequisite: Latin 300 a and b or equivalent. *Mr. Charles*

Latin 490a, b. Special Topics in Roman Literature (0-0-3, each sem.).

Independent work for qualified upperclassmen in genres or authors not presented in other upper-level courses: may be repeated for credit. *Staff*

Classics 315a. Greek Literature in Translation (3-0-3).

A study of the Greek creative achievement in epic and lyric poetry and in drama. Open to Sophomores with permission of the instructor. Offered in alternate years: will be given in 1969-70. *Mr. Levin*

Classics 315b. Greek Literature in Translation (3-0-3).

A continuation of the foregoing: Greek historians, orators, philosophers. Open to Sophomores with permission of the instructor. Offered in alternate years: will be given in 1969-70. *Mr. Charles*

Classics 316a. Roman Literature in Translation (3-0-3).

Major achievements in dramatic, lyric, and epic poetry will be studied, with due attention given both to Greek influence and to Roman originality. No prerequisite, although the sequence of 315a, b and 316a, b is strongly recommended. Open to Sophomores with permission of the instructor. Offered in alternate years: will be given in 1968-69. *Mr. Charles*

Classics 316b. Roman Literature in Translation (3-0-3).

A continuation of the foregoing: readings in Roman oratory, historical writing, and philosophy. No prerequisite; but note the recommendation made above regarding Classics 316a. Open to Sophomores with permission of the instructor. Offered in alternate years: will be given in 1968-69. *Mr. Levin*

Classics 320a, b. Trends in European Culture during Antiquity and the Middle Ages (3-0-3, each sem.).

This course traces selected aspects of European thought from Periclean Athens to the later Middle Ages, with special reference to Hellenistic and Greco-Roman influences. Religious, philosophical, and scientific implications are examined in some detail. Offered in alternate years: given in 1968-69. Prerequisite: History 200a, 201b. Also offered as History 320a,b. *Mr. Lear*

Classics 430a, b. Topics in Ancient and Medieval Intellectual History (3-0-3, each sem.).

This course deals with selective phases of classical and medieval thought based on the cultural monuments of antiquity and the Middle Ages. Intensive reading and reports on special aspects of the field. Offered in alternate years: given in 1969-70. Prerequisite: History 200a, 201b. Also offered as History 430a, b. *Mr. Lear*

ITALIAN

Italian 100a, b. Elementary Italian (3-2-4, each sem.).

Introduction to the study of the Italian language, with emphasis on the development of audio-lingual skills. Graded readings will be used to introduce the student to the basic elements of Italian culture and civilization. Language laboratory work required. *Staff*

Italian 200a, b. Intermediate Italian (3-0-3, each sem.).

Emphasis on intensified oral and written practice. Review of grammar. An introduction to the culture and civilization of Italy. Readings of contemporary short stories and plays. *Staff*

PORTUGUESE

Associate Professor Leal de Martínez

Portuguese 100a, b. First-Year Portuguese (3-2-4, each sem.).

Introduction to the study of the Portuguese language, with emphasis on the development of audio-lingual skills. Language laboratory work required. *Mrs. Leal de Martínez*

Portuguese 200a, b. Second-Year Portuguese (3-0-3, each sem.).

The first part of this course is devoted to a comprehensive review of grammar which will gradually lead the student to engage in natural conversation. Contemporary short stories will provide current linguistic models and serve as the point of departure for class conversation and discussion. The second part of the course is intended to introduce the student to the main currents of Portuguese literature. *Mrs. Leal de Martínez*

RUSSIAN

Associate Professor Jitkoff
Assistant Professor Skarginsky

Russian 100a, b. Elementary Russian (3-2-4, each sem.).

Pronunciation, grammar, introduction to conversation, graded reading, and practice in translation. Language laboratory work required. *Staff*

Russian 110a. Russian for Graduate Students (3-0-0).

A noncredit course in Russian, restricted to graduate students preparing for the graduate language examination. *Mr. Jitkoff*

Russian 200a. Intermediate Russian 3-0-3).

Designed to provide practice in reading, composition, and comprehension. Prerequisite: Russian 100b. *Staff*

Russian 200b. Intermediate Russian: Literary (3-0-3).

Introduction to Russian literature with emphasis on composition. Outside reading required. Prerequisite: Russian 200a. *Staff*

Russian 201b. Intermediate Russian: Scientific (3-0-3).

Reading and translation in field of major study. Prerequisite: Russian 200a. *Mr. Jitkoff*

Russian 300a. Russian Culture and Civilization (3-0-3).

Reading and discussion on topics related to the development of Russian civilization. Oral and written reports on assigned topics. The course will be conducted in Russian. Prerequisite: Russian 200b or 201b. Offered in alternate years: will be given in 1967-68. *Mr. Jitkoff*

Russian 300b. Reading in Russian Classics (3-0-3).

Reading in Russian literature. Oral and written reports on assigned topics. The course will be conducted in Russian. Prerequisite: Russian 300a. Offered in alternate years: will be given in 1967-68. *Mr. Jitkoff*

Russian 330a, b. History of Russian Literature (3-0-3, each sem.).

A comprehensive survey of Russian literature from its beginning to the twentieth century. Prerequisite: Russian 200b. Offered in alternate years: will be given in 1968-69. *Staff*

Russian 450a, b. Independent Work: Special Topics in Russian Literature. (0-0-3, each sem.).

Research for qualified upperclassmen. *Mr. Jitkoff*

SPANISH

Associate Professors Castañeda, Leal de Martínez
Assistant Professors Lendinez and Urrutibeheity
Instructor Green

Requirements for an Undergraduate Major in Spanish. Ten of the semester-courses offered in fulfillment of major requirements must be Spanish courses numbered 300 or higher. Qualified upperclassmen are offered an opportunity to earn up to six hours of credit in independent work. All departmental majors must have their programs approved by the department.

COURSES

Spanish 100a, b. First-Year Spanish (3-2-4, each sem.).

Introduction to the study of the Spanish language, with emphasis on the development of audio-lingual skills. Graded readings will be used to introduce the student to Hispanic culture and civilization. Language laboratory work required. *Staff*

Spanish 110b. First-Year Spanish (3-2-3).

A presentation of the fundamentals of Spanish grammar. Language laboratory work required. *Miss Lauderdale*

Spanish 200a, b. Second-Year Spanish (3-0-3, each sem.).

The first part of this course is devoted to a comprehensive review of grammar which will gradually lead the student to engage in natural conversation. Contemporary short stories will provide current linguistic models and serve as the point of departure for class conversation and discussion. The second part of the course is intended to introduce the student to the main currents of Hispanic literature. *Staff*

Spanish 210a, b. Second-Year Spanish (3-0-3, each sem.).

Designed for students who have successfully completed Spanish 110. Review of grammatical patterns and selected readings of cultural interest. *Miss Lauderdale*

Spanish 300a, b. Hispanic Culture and Civilization (3-0-3, each sem.).

Topics relating to the development of social, political, and economic institutions of Spain will form the basis for extensive conversation, discussion, and composition. Thus, while further developing his language skills, the student will also be introduced to the cultural reality of the Hispanic world. Will be given in 1967-68. *Mr. Lendinez*

Spanish 320a, b. Survey of Spanish-American Literature (3-0-3, each sem.).

A study of the main trends and outstanding writers of Spanish America. Offered in alternate years: will be given in 1968-69. *Mrs. Leal de Martinez*

Spanish 340a, b. Spanish Literature from 1800 to the Present (3-0-3, each sem.).

Particular emphasis on Romantic drama, Galdós, the generation of '98, García Lorca, and contemporary novel and theater. Offered in alternate years: will be given in 1967-68. *Mrs. Lead de Martinez*

Spanish 350a, b. History of the Spanish Language (3-0-3, each sem.).

The development of Spanish from the Romanization of Spain to our times. Linguistic, cultural, social, and regional factors which have led to modern Spanish. Required for students majoring in Spanish. Prerequisite: Spanish 200a,b or its equivalent. Offered in alternate years: will be given in 1967-68. *Staff*

Spanish 360a, b. Golden Age Drama 3-0-3, each sem.).

The development of the "comedia" as illustrated by selected works of Lope de Vega, Tirso de Molina, Ruiz de Alarcón, Calderón de la Barca, and other seventeenth-century playwrights. Offered in alternate years: will be given in 1967-68. *Mr. Castañeda*

Spanish 380a, b. Prose and Lyric Poetry of the Golden Age (3-0-3, each sem.).

Intensive and detailed analysis of selected texts in poetry and prose, emphasizing mysticism, the development of lyric poetry from Garcilaso to Góngora, the picaresque novel, and Cervantes. Offered in alternate years: will be given in 1968-69. *Mr. Castañeda*

Spanish 400a, b. Survey of Spanish Literature (3-0-3, each sem.).

Representative readings from the medieval period to the present, while providing a panoramic view of the history of Spanish literature, will also be used to develop the student's ability in literary study and stylistic analysis. Offered in alternate years: will be given in 1968-69. *Mr. Lendinez*

Spanish 420a, b. Independent Work: Special Topics in Spanish Literature (0-0-3, each sem.).

Reserved for qualified upperclassmen who are particularly interested in an author or period not covered in other courses. Permission of the department required.

Staff

Commerce

Associate Professor Hale, *Chairman*
and Staff

COURSES

Commerce 110a, b. Business Mathematics (3-0-3, each sem.).

Linear equations; exponents and radicals; quadratic equations; binomial theorem; logarithms; curve plotting. Compound interest and annuities; sinking funds; permutations and combinations; introduction to probability.

Commerce 210a, b. Introduction to Business (3-0-3, each sem.).

Historical, economic, and social setting of business enterprise; descriptive analysis of business activity.

Commerce 300a, b. Financial Control (3-0-3, each sem.).

Introduction to the methods of accounting for partnerships and corporations; concepts of costs, income, and profit; financial analysis; problems in valuation, depreciation, and surplus accounting.

Commerce 310a. Business Statistics (3-0-3).

Collection, classification, and presentation of data; use of graphic methods; frequency distributions; sampling; time series; index numbers; correlation.

Commerce 315b. Finance and Banking (3-0-3).

Functions and theory of money and credit; principles of commercial banking; the Federal Reserve System.

Commerce 410a. Marketing (3-0-3).

Marketing functions and institutions; role of commodity characteristics and the choice of distribution channels; financing marketing activities; management and control of marketing risks.

Commerce 415b. Business Finance (3-0-3).

Short- and long-term financing of assets; investment banking; tools of financial analysis; budgets and financial planning.

Commerce 420a. Business Organization I (3-0-3).

Personnel management and employee relations; personnel policies; job evaluation; wage and salary administration; employee services; labor legislation.

Commerce 425b. Business Organization II (3-0-3).

Principles of internal organization and control; selected topics in business policy.

Economics and Business Administration

Professors Edwards, Krzyzaniak, Levy, Rimlinger, *Chairman*
Associate Professors Besen, Huddle
Simons, Soligo, Wiest, and Young
Adjunct Associate Professor Land
Assistant Professors Davis, McLure, Nissen,
Seagrave, and Smith
Lecturers Cruikshank, Farb, Giles and Viebig

The Undergraduate Program in Economics. Undergraduate majors are required to take ten semesters of approved departmental courses. These must include Economics 200a and b, Business Administration 200b, Economics 350a, and two additional 300 numbered courses. At least two courses for the major must be drawn from Economics 420a, 430a, 435a, 440a, 450b, and 475a. Students intending to major in economics are urged to take Economics 350a in their sophomore year. Mathematics 360a may be substituted for Economics 350a. Mathematics 360a and b is recommended for students intending to do graduate work in Economics. Furthermore, in lieu of one or two semesters of course work, the department offers an independent work program, admission to which is granted on a selective basis.

The Five-Year Program in Accounting. Students primarily interested in accounting may, with departmental approval, extend their training into a fifth year. To be eligible for this program students must have successfully completed a Bachelor's degree, whether with a major in economics or some other field. Students who are interested in the five-year program are advised to enroll in Business Administration 200b in their Sophomore year, Business Administration 300a,b in their Junior year, and Business Administration 400a in their Senior year. In the fifth year, students are required to enroll in three full-year advanced accounting courses and two additional upperclass-courses outside the department. Upon the successful completion of these requirements a student is awarded the degree of Bachelor of Science in Accounting. This program is designed for those who wish to prepare themselves for careers in public accounting as well as for positions of managerial responsibility in business.

The Graduate Program in Economics. Admission to graduate study in economics is granted each year to a limited number of students who hold an undergraduate degree (or the equivalent), whether in economics or another field. The graduate program is designed primarily for students qualified to pursue a course of study leading to the Ph.D. degree. Some training in mathematics at the undergraduate level is advisable but is not a prerequisite of admission. The Eco-

nomics Department also offers graduate work leading to the M.A. degree.

Candidates for the Ph.D. degree who have good undergraduate preparation in economics should expect to devote two years to full-time study (or the equivalent) before taking the general examination which must be passed before the submission of the doctoral dissertation. A minimum of one additional year is usually necessary for completion of the dissertation. Applicants are required to take the Graduate Record Examination.

The aim of the graduate program is to provide thorough training in economic theory and in the use of quantitative methods of analysis, and also to afford an understanding of modern economic institutions and policy problems. Those successfully completing the Ph.D. program will be prepared for careers as professional economists in teaching, business, and government.

Instruction is carried on in small classes, seminars, and tutorials in which student participation is emphasized. Close contact with the faculty is encouraged as a means of stimulating and sustaining student interest in research problems.

Supplemental facilities and opportunities include:

(1) Participation in the Economics Seminar which meets at least once a month to hear visiting economists, departmental faculty, and graduate students present results of current research.
(2) Use of a large-scale digital computer in connection with advanced research and courses.
(3) Enrollment in graduate courses in such related subject areas as history, mathematics, philosophy, and engineering.

Candidates for the doctor's degree will be expected to:

(1) Pass a reading examination in either French or German by the end of the first year of residence. Another language may be substituted for one of these with permission of the Graduate Committee.
(2) Demonstrate proficiency in statistics, elementary mathematical economics, and economic history or history of economic thought.
(3) Complete an approved program of graduate courses.
(4) Pass a written set of general examinations consisting of:
    a. Economic Theory
    b. A major field examination covering one of the following five areas:

I

Industrial Organization
Labor Economics
Managerial Economics

II

Mathematical Economics
Systems Theory *or* Econometrics

III

Public Finance
Monetary Theory
Monetary and Fiscal Policy

IV

International Trade
International Finance
Economic Growth and Development

V

History of Economic Thought
American Economic History
European Economic History

c. Two approved minor field examinations covering two areas outside of the major field. A minor field is defined as one of the specific subject areas listed in the above major fields. In addition, the following may be offered as minor areas:
   Comparative Economic Systems
   Non-Market Decision Making
   An Outside Field, e.g. Social Psychology, American Government, etc.
   Theory of Accounts

(5) Upon satisfatory completion of the written examinations, pass an oral examination emphasizing economic theory and the major area.
(6) Submit (with the approval of the advisory committee) and successfully defend in an oral examinaion a doctoral dissertation setting forth in publishable form the results of original research.

Candidates for the master's degree in economics are expected to fulfill the following requirements:

(1) Complete successfully an approved program of graduate courses.
(2) Demonstrate proficiency in the use of statistics.
(3) Make a successful oral defense of a thesis presenting in prescribed form the results of original research.

ECONOMICS COURSES

Economics 200a, b. Principles of Economics (3-0-3, each sem.).

The principles of modern economics and the history of economic thought and controversy. The first part of the course is concerned with the theory of national income determination, price and distribution theory, and the theory of trade. In the second part of the course the great economic ideas and issues of the past and

present are studied, with emphasis on those ideas and policy issues of continuing influence in national and international economic affairs.

Economics 350a. Elements of Statistical Method (3-2-3).

Basic concepts and techniques in probability theory and statistical inference.

Economics 355a. Money and Banking (3-0-3).

Determinants of the demand for money; the relationship between money and national income; American financial institutions; instability of prices and income and the role of monetary policy; conflicts between internal and external stability. Prerequisite: Economics 200a.

Economics 370a. Economic Analysis I (3-0-3).

A course in intermediate theory devoted to the study of economic equilibrium and market relationships; the theories of the firm and the household, of income distribution, and of general equilibrium. Prerequisite: Economics 200a.

Economics 375b. Economic Analysis II (3-0-3).

The theory of national income determination and economic growth; a critical consideration of selected theories of income fluctuations; some application of theory to policy questions. Prerequisite: Economics 200a.

Economics 403a or b. Senior Independent Research (0-0-3).

A one semester independent research project for Seniors on an approved topic of their own choosing, under the supervision of a faculty advisor. Requires the preparation of a paper embodying the findings of the research. Enrollment is by special permission and on the basis of an approved research topic.

Economics 404a, b. Senior Honors Thesis (0-0-6).

A two semester sequence in which each student is required to undertake intensive research on a topic approved at the end of his Junior year. The results of this research are to be incorporated in a thesis submitted in the spring of the Senior year. Enrollment by special permission and on the basis of an approved research topic.

Economics 410b. Economics of Labor Relations (3-0-3).

A survey of the history and current status of the labor movement in the United States; organization and structure of labor unions; trends in labor legislation; collective bargaining and the settlement of labor disputes; wage and employment theory; social insurance; current labor problems and issues. Prerequisite: Economics 200a or approval of the instructor.

Economics 420a. International Economics (3-0-3).

A study of the economic relationships between separate countries in the international economy; trade theory; balance of payments analysis; international finance; tariffs and other trade restrictions; current policy issues. Prerequisite: Economics 200a.

Economics 430b. Comparative Economic Systems (3-0-3).

Theoretical models of various economic systems are presented as a basis for analyzing the operation and the institutional characteristics of several economies, including the U.S., the U.S.S.R., Great Britain, India, and China. Prerequisite: Economics 200a.

Economics 435a. Industrial Organization (3-0-3).

An analysis of market structure, behavior, and performance, including the static case for competition as qualified by dynamic considerations, especially innovation. Also case studies of industries and the interpretation of American anti-trust laws. Prerequisite: Economics 200a or approval of instructor.

Economics 440a. Non-Market Decision Making (3-0-3).

An introduction to the use of abstract logical models in political and non-market decision making. Existing models, closely resembling those used in economics, will be explored in detail and their application to specific problems examined. The emphasis will be on simpler political models, but extensions to more complex models will be discussed. (Also offered as Political Science 440a.)

Economics 445a. Linear Programming (3-0-3).

An introduction to analytical and mathematical methods useful in managerial decisions. Primary emphasis is placed on linear programming formulations and solutions of management problems. Prerequisite: Economics 200a.

Economics 446b. Managerial Economics (3-0-3).

The application of economics to decision making within the firm. Topics include organization theory, cost and pricing policies, capital budgeting, and problems of control. Prerequisite: Economics 200a.

Economics 450b. Economic Growth and Development (3-0-3).

An analysis of the mechanics of economic growth in general and specific investigations of economic development of underdeveloped areas, including problems of capital formation, manpower mobilization, population pressures, and economic and social organizations. Prerequisite: Economics 200a.

Economics 475a. Taxation and Fiscal Policy (3-0-3).

An analysis of taxation and expenditure policies at the federal, state, and local levels and their contribution to efficient resource allocation, equitable income distribution, full employment, and economic growth. Prerequisite: Economics 200a.

Economics 480a, b. Operations Research (3-0-3, each semester may be taken separately).

An analysis of economic systems and relevant decision models, including interest formulas, present value analysis, capital investment decisions, depreciation and tax problems. A study of elementary stochastic processes, including Markov chains, queuing models, inventory theory, stochastic replacement problems, reliability and other selected topics. Prerequisite: Economics 200a. (Also offered as Engineering 480a,b.)

Economics 490a. Development of Economic Institutions (3-0-3).

A seminar devoted to analysis of the impact of technological change and political and social developments upon the evolution of economic institutions. Economic forces which lie beyond supply-and-demand factors in the market economy are investigated. The course surveys the works of leading institutional economists and social anthropologists as a point of departure for research and discussion.

Economics 495a. Senior Seminar (3-0-3).

Reading and discussion of selected topics in advanced economics. Open to Seniors with special approval.

Economics 500. Economic Research.

Research on an approved topic in partial fulfillment of the requirements for the master's degree.

Economics 501. Price Theory (3-6-5).

Microeconomic theory Topics studied include the theory of the firm, the theory of consumer behavior, duopoly, bilateral monopoly, imperfect competition, capital theory, and the theory of income distribution.

Economics 502. Income and Employment Theory (3-6-5).

Macroeconomic theory of employment, interest, and income. Considers the work of Keynes and subsequent developments.

Economics 503. Topics in Economic Theory (3-6-5).

Selected theoretical issues in the areas of capital, welfare economics, uncertainty, growth, and income.

Economics 504. Theory of Public Finance (3-6-5).

An analysis of governmental revenue and expenditures. Topics include welfare economics and market failure, government expenditures and budgeting, principles of taxation, the United States tax system and its incidence and other economic effects, debt burden, fiscal federalism, and international aspects of taxation.

Economics 505. Monetary Theory (3-6-5).

Modern monetary theory. The economics of money, banking, and finance.

Economics 506. Monetary and Fiscal Policy (3-6-5).

Selected theories of monetary and fiscal policy and their application. Analysis of contemporary policy issues.

Economics 507. Elementary Mathematical Economics (3-6-5).

Introduction to mathematical theories of economics. Theory of choice, preference and utility. Survey of simple models of exchange, production and consumption, and market equilibrium. Elements of programming, games, operational analysis.

Economics 508. Advanced Mathematical Economics (3-6-5).

The mathematical framework and the analytical investigation of fundamental models in economics.

Economics 509. Advanced Statistics (3-6-5).

Statistical inference and the testing of hypotheses; multiple and partial correlation analysis; selected topics in time-series analysis and index-number construction.

Economics 510. Econometrics (3-6-5).

Mathematical models of economic behavior and their numerical evaluation by statistical methods.

Economics 511. Topics in Policy and Applied Economics (3-6-5).

Selected research problems in economic development, economic planning, national income accounting, and industrial organization.

Economics 512. International Trade Theory (3-6-5).

Classical, neoclassical, and modern trade theory; balance of payments equilibrium; some welfare aspects of trade. Offered in alternate years.

Economics 513. Topics in Managerial Economics (3-6-5).

Theory of investment of the firm; organization theory; problems in applying theory in decision-making.

Economics 514. Industrial Organizations and Control (3-6-5).

Industrial markets and public policy. Examines the determinants and implications of price and production policies and also considers the adequacy of the antitrust laws in relation to the problems of industrial organization.

Economics 515. Labor Economics (3-6-5).

The economics of the labor market and the economic implication of trade unions. Attention is given to major public policy issues.

Economics 516. Economic History and Development (3-6-5).

An historical analysis of the economic growth and industrialization of the U.S., Western Europe, and Russia in the last 150 years. Stresses the conditions which favored or retarded growth in different times and places.

Economics 517. History of Economic Thought and Methodology (3-6-5).

The development of economic thought and methodology from the seventeenth century to the present. Emphasis is given to classical and neoclassical doctrines reflected in modern economic theory and analytical techniques.

Economics 518. International Finance (3-6-5).

Analysis of international monetary problems; foreign-exchange theory; international investment. Offered in alternate years.

Economics 519. Economic Growth and Development (3-6-5).

A analysis of theory and policy questions relating to the level and rate of economic development. An examination of development problems, plans, and planning techniques in selected countries.

Economics 527. Fundamentals of Nonlinear Systems (3-0-3).

Intrinsic properties of nonlinear deterministic and random systems including stability, observability and controllability. An introduction to approximation theory and its application to nonlinear estimation. Also offered as Chemical Engineering 517 and Electrical Engineering 517.

Economics 528. Fundamentals of Optimization Theory (3-0-3).

A discussion of the mathematical problems encountered when searching for the best element in a given set. Existence and nonexistence of extrema. Introduction to linear, nonlinear, and dynamic programming, combinatorial problems, variational calculus, and optimal control theory. Also offered as Chemical Engineering 518 and Electrical Engineering 518.

Economics 529. Advanced Mathematical Programming (3-0-3).

Theory, computational methods, and applications of various advanced programming models are discussed. Topics include: nonlinear programming; Kuhn-Tucker theory; integer programming; network models; programming models subject to stochastic influences. Understanding of the simplex method is assumed. Prerequisites: Economics 528 or Economics 445 or equivalent. Also offered as Chemical Engineering 519 and Electrical Engineering 519.

Economics 600. Economic Research.

Research on an approved topic in partial fulfillment of the requirements for the doctor's degree.

BUSINESS ADMINISTRATION COURSES

Business Administration 200a, b. Introduction to Business Administration (3-0-3).

Basic accounting principles; financial statements; interpretation of financial and operating reports.

Business Administration 300a. Principles of Accounting I (3-0-3).

Study of accounting procedures and principles at the intermediate level; financial statements; net income concepts; capital stock, retained earnings, and dividends; generally accepted accounting principles; accounting for current assets and investments. Prerequisite: Business Administration 200a or 200b.

Business Administration 300b. Principles of Accounting II (3-0-3).

Study of accounting for fixed assets, liabilities, and reserves; analysis and interpretation of statements and operations; combination and reorganizations; fund flows; allocation of income taxes; price-level impact on financial statements. Prerequisite: Business Administration 300a or permission of the instructor.

Business Administration 430. Quantitative Methods (3-0-3).

An introduction to quantitative methods of data analysis and problem solving useful for managerial decision making, including inventory and waiting line models, simulation, linear programming, and network models. The computer as a tool for quantitative analysis.

Business Administration 500a. Managerial Accounting (3-0-3).

An intensive study of the accumulation, analysis, reporting, and use of accounting data for business planning, control, and operations.

Business Administration 501a. Advanced Accounting (3-0-3).

Partnership; statement of affairs; receiverships; actuarial science; estates and trusts; parent and subsidiary accounting; consolidated statements; foreign exchange and public accounts. Prerequisite: Business Administration 300a and 300b or permission of instructor.

Business Administration 510a, b. Federal Taxes (3-0-3, each sem.).

A study of Federal taxation of individuals, trusts, estates, partnerships, and corporations, with required research and writing on tax problems.

Business Administration 515b. Auditing (3-0-3).

An intensive study of financial examination theory, organizational control, and operations auditing.

Business Administration 520a. Theory of Accounting (3-0-3).

Topics of current interest arising from the search for generally acceptable accounting principles. Study of inconsistencies between current theory and practice. Applications of economic analysis to accounting concepts.

Education

Professor Wood, *Chairman*
Assistant Professor Duke
Lecturers Baum and Buse

Teacher Education and Certification. Rice University seeks to contribute graduates to society able to think and to question, educated to comprehend and to cope with a rapidly changing world. Although professional instruction is not the primary ingredient of undergraduate education, the University's role in preparing students for their future life work cannot be ignored. While maintaining complete institutional integrity, Rice University supports the intention as well as the letter of regulations promulgated by the state governing the development and presentation of teacher preparation and certification programs.

To this end Rice University has a Department of Education which closely cooperates with departments offering work in subject-matter fields. It is the function of this department to provide rigorous professional courses and to administer the established teacher education programs.

The Rice University teacher education program strives to fit the

prospective teacher to perform all the roles which may be expected of him. To accomplish this objective, it gives sustained close attention to the following vitally interrelated components:

A. a sound liberal or general education
B. an extended knowledge of the subject(s) or area(s) to be taught
C. professional knowledge, as distinguished from professional skills (i.e., relevant historical, philosophical, social, and psychological material)
D. skills in managing a classroom, in working with children and people, and in the supervision of the learning process.

Admission to the Teacher Education Program. Students who have satisfied the following requirements may apply to the Education Council for admission to the teacher education program:

1. Junior standing at Rice University
2. Satisfactory completion of History 110a,b: American History
3. A grade average of 3 or better in at least 75 per cent of all semester hours attempted in teaching field offered for approval
4. Passing grades in Freshman and Sophomore English courses
5. Given evidence of satisfactory speech patterns
6. Provided evidence of adequate physical vigor and strength and absence of obvious physical conditions which might interfere materially with performance in a classroom as a teacher
7. Approval of a completed Teacher Certification Program form by the appropriate departmental representatives and the Education Council prior to registration for the Junior year
8. Approval of the completed form "Application for Admission to the Teacher Education Program" by the Education Council prior to registration for the Junior year

Texas State Requirements for Secondary Provisional Certificate (Grades 7-12)

A Provisional Teacher's Certificate is based upon a bachelor's degree, satisfactory completion of an approved teacher-preparatory program, and the recommendation of the University. Rice University is approved to offer the following teacher-preparatory programs: biology, chemistry, English, French, German, health and physical education, history, Latin, mathematics, physics, Spanish, general science, and social studies.

The approved program shall consist of the following:

1. *Foundations in Arts and Sciences:* Approximately two years including:

A. English	12 semester hours
American History	6 semester hours
Government	6 semester hours

From two of the following: 12 semester hours
Science
Mathematics
Foreign Language

B. Other institutional degree requirements

2. *Academic Specialization:*

Plan I. Preparation to Teach Two Fields:
24 semester hours in each area including 12 semester hours of advanced work in each, with approval of the Rice Education Council.

Plan II. Preparation to Teach Related Fields:
48 semester hours in a composite field (general science or social studies) with at least 18 semester hours of advanced work and with approval of the Rice Education Council.

3. *Professional Education:* 18 semester hours of which 6 semester hours shall be in student teaching.

4. *Elective courses.*

Requirements for Completion of the Teacher Education Program

To be recommended to the Texas Education Agency for certification, a student must satisfy all institutional requirements for a bachelor's degree which will include:

1. Completion of History 110a,b and Political Science 210a,b before the Junior year
2. Twenty-four semester hours of credit in each of two teaching fields or forty-eight semester hours of credit in a composite field.
3. Completion of the required professional education courses. Education 310a,b is to be taken in the Junior year and Education 410a,b in the Senior year
4. Satisfaction of the supervised student teaching requirement (Education 420) as outlined below.

COURSES

Education 310a. The Historical and Philosophical Foundations of Education (3-0-3).

A study of secondary education's historic function in the United States; intellectual foundations of modern educational thought and practice; philosophic analysis of contemporary and recent theories useful in planning the educative activities of the secondary school. Prerequisite: History 110 or consent of the instructor and filing of Teacher Certification Plan.

Education 310b. Human Development: The Psychology of Human Learning (3-0-3).

Introductory survey of theoretical systems in the field of human learning together with a consideration of their implications for education; motivation; personality development in adolescence; statistics; tests and measurement; evaluation.

Education 410a. Fundamentals of Secondary Education (3-0-3).

Background and purposes of the secondary school; trends in modern secondary education; curriculum of the secondary school; current trends in school administration; essentials of educational research.

Education 410b. Seminar in Teaching (3-0-3).

Problems that face the beginning teacher; current trends in effective teaching materials and procedures; comprehensive study of materials and procedures for teaching the student's subject-matter field of specialization in preparation for actual teaching; observation of, and orientation to, public school teaching.

Education 420. Principles of Teaching: Introduction to Teaching in the Secondary School and Supervised Teaching. (Credit: 6 semester hours.)

NOTE: *Either of two distinct plans may be followed by teacher education candidates. The main difference is the type of supervised teaching experience provided.*

The Apprenticeship Plan (Plan A):

Prerequisite: Education 310a,b.

Apprenticeship is designed for students who wish to complete preparation for their teaching careers in four years and two six-week summer sessions. Candidates will enroll for the summer session following their Junior year. The Apprentice will observe teaching, act as a helping teacher, and perhaps teach as may be appropriate in the Rice Summer School for High School Students.

Education 410a,b is to be completed during the Senior year.

Following graduation from Rice the Apprentice will attend the summer session for full-time teaching in the Rice Summer School for High School Students under the supervision and guidance of a Master Teacher and the University staff. While the Apprentice spends somewhat less time in student teaching than under the Internship Plan, he is not remunerated for his teaching service. The Apprentice is to be recommended for a Texas Provisional Teacher's Certificate following successful completion of his second summer session.

The Internship Plan (Plan B):

Prerequisites: Education 310a,b and Education 410a,b

Under this plan students are expected to attend a six-week summer session immediately following their graduation from Rice. Each Intern will observe and teach classes under the supervision of a Master Teacher and a University staff member in the Rice Summer School for High School Students. During the following fall semester Interns will be assigned to classrooms in neighboring school systems for full-time duty. Two Interns will be employed as a pair to take the place of a normally employed teacher. Each Intern is to teach three periods per day under supervision and guidance of a teacher at his assigned school and a staff member from the University. During the half-year

of their service Interns will be paid a salary commensurate with the salary being paid to substitute teachers by cooperating school systems for their employment as classroom teachers. Interns successfully completing their teaching assignment will be offered a regular contract to teach the spring semester and will be recommended for a Texas Provisional Teacher's Certificate.

Electrical Engineering

(*See* pages 168-174)

Engineering and Applied Science

General Undergraduate Information. Curricula in engineering at Rice University lead to degrees in the fields of chemical engineering, civil engineering, electrical engineering, and mechanical engineering.

The first two years of the science-engineering program taken by all engineers are described generally on pages 56-59. Sophomore students contemplating a major in engineering should pay particular attention to the electives recommended under the special engineering departments.

The following undergraduate courses listed as "Engineering" are offered for the preparation of students majoring in all branches. For requirements of each department, reference should be made to the appropriate section.

COURSES

Engineering 200. Classical Thermodynamics (3-0-3).

A fundamental exposition of the laws of classical thermodynamics and the deductions that may be made therefrom. Applications of these principles are illustrated for systems of significance in various disciplines with particular attention to pure substances. Prerequisite: Physics 100a,b.

Engineering 201. Engineering Graphics I (1-5-3).

An engineering course which develops graphics as a method of exchanging ideas. Included are orthogonal projection, sketching, dimensioning, ASA and SAE standards, pictorial projection, and lettering. Staff approval of all drawing instruments is required. Laboratory fee required.

Engineering 202. Engineering Graphics II (1-5-3).

Emphasis on the graphical method of solving technical problems. Included are graphical arithmetic, graphical calculus, nomography, and relationships of algebraic and graphical solutions of problems in space. Prerequisites: Engineering 201 and completion of or registration in Mathematics 200a,b or 210a,b.

Engineering 211. Engineering Mechanics I (3-0-3).

Equilibrium of static systems, dynamics of a particle, vibrating systems. Prerequisites: Physics 100a,b, Mathematics 100a,b.

Engineering 212. Engineering Mechanics II (3-0-3).

Dynamics of systems of particles, moments and products of inertia, dynamics of rigid bodies, Lagrange's equations. Prerequisite: Engineering 211.

Engineering 240. Introduction to Computer Science (2-3-3).

The nature of the digital computer. Programming; algorithms and flow charts; languages. Data structure and representation. Numeric and non-numeric computing techniques. Introduction to numerical analysis. Prerequisite: Mathematics 100.

Engineering 241. Systems, Signals, and Electronic Devices (3-4-4).

A survey of modern electrical engineering stressing the fundamental concepts of systems, signals, circuits and electronic devices including an introduction to instrumentation. Prerequisite: Mathematics 100a,b, or equivalent.

Engineering 471. Applied Mathematics I: Linear Algebra (3-0-3).

Discussion of elementary properties of finite dimensional real vector spaces. Topics included are inner product spaces, linear transformations, matrices, determinants, eigenvalue problems, and applications.

Engineering 472. Applied Mathematics II: Complex Variables (3-0-3).

Discussion of the elementary concepts of complex variable theory. Topics included are complex numbers, complex functions, differentiation, analytic functions, contour integration, complex series, analytic continuation, residue theory, conformal mapping, and transform theory.

Engineering 475. Probability Theory (3-0-3).

Sets and events. Fundamental probability model, random variables, mathematical expectation, and limit theorems. Introduction to random processes. Attention is given to the role of fundamental concepts in both the development of the mathematical theory and in the application of this theory to a variety of practical problems.

Engineering 476. Mathematical Statistics; Random Processes (3-0-3).

Fundamental probability theory applied to problems of statistical inference. Some selected topics in random processes. Continuation of Engineering 475.

Engineering 480a, b. Operations Research (3-0-3, each semester may be taken separately).

An analysis of economic systems and relevant decision models, including interest formulas, present value analysis, capital investment decisions, depreciation and tax problems. A study of elementary stochastic processes, including Markov chains, queing models, inventory theory, stochastic replacement problems, reliability and other selected topics. Prerequisite: Economics 200a. (Also offered as Economics 480a,b).

Engineering 571. Applied Mathematics III: Distributed-Parameter Problems; Perturbation Theory (3-0-3).

Distributed-parameter problems will be discussed with physical examples from fluid flow, electromagnetic field theory, elasticity, heat conduction, transport phenomena, etc. Mathematical methods for solution will include separation of variables, transform techniques, and the method of characteristics. The course will also contain an introduction to perturbation theory in ordinary differential equations and variational methods.

Engineering 572b. Numerical Methods (3-0-3).

Numerical methods and applications including interpolation, solution of systems of equations, numerical integration and differentiation, and solution of ordinary

and partial differential equations by finite difference methods. A digital computer is used in exercises.

Engineering 671. Applied Mathematics IV: Approximation Methods; Ordinary and Partial Differential Equations (3-0-3).

Approximation methods in ordinary and partial differential equations will be discussed including saddle-point integration, boundary-layer theory, and general asymptotic methods.

Engineering 672. Applied Mathematics V: Advanced Topics (3-0-3).

Mathematical topics will include integral equations, the Wiener-Hopf method in integral and partial differential equations, and variational methods.

Engineering 673b. Applied Mathematics VI: Applied Functional Analysis (3-0-3).

Topological vector spaces. Functionals and operators in Banach and Hilbert spaces. Minimum effort and estimation problems. Applications to adaptive and learning systems. Prerequisite: Mathematics 410b or consent of instructor.

Chemical Engineering

Professors Akers, Deans, Hellums, Horn, Jackson, Kobayashi, and Leland, *Chairman*
Associate Professors S. Davis and Hightower
Assistant Professors Dyson and G. Fisher

Undergraduate Program. A general outline of the undergraduate engineering program is given on pages 57-59. Chemistry 200a,b is required for chemical engineering majors and is normally taken during the Sophomore year.

The undergraduate curriculum in chemical engineering is designed to provide a sound scientific and technical basis for further professional development. At the same time, the curriculum affords each student an opportunity to specialize in one of a number of technical areas. At the beginning of his fourth year, the student selects an integrated sequence of technical electives for his last two years. This group of courses, chosen with the counsel of a faculty adviser, is intended to give the student greater depth in an area of particular interest to him. Examples of such areas are applied mathematics, nuclear technology, environmental science and engineering, chemical process kinetics, engineering economics, process dynamics and molecular or continuum mechanics.

After completing four years of his curriculum, the student receives a Bachelor of Arts degree, with a chemical engineering major. If his achievement is satisfactory, he then qualifies for a fifth year of study leading to the professional degree, Master of Chemical Engineering.

Students with special interest in research may, upon recommenda-

tion of the department and approval of the Graduate Council, enter a program leading directly to the Master of Science degree after completing the Bachelor of Arts degree.

Graduate Program. Graduate study in chemical engineering can lead to either the Master of Science or the Doctor of Philosophy degree. University requirements for these degrees are outlined on pages 99-104.

A candidate for the Master of Science degree is required to complete a minimum of eight approved one-semester courses with high standing. He must also submit, and defend in an oral examination, a thesis indicating his research ability.

A candidate for the Doctor of Philosophy degree must demonstrate his competence in the areas of applied mathematics, thermodynamics, and transport processes, as well as in his chosen field of interest. He must also pass a qualifying examination, normally during his second year of residence. His thesis must be defensible evidence of his ability to carry out meaningful research in a specialized area of chemical engineering.

In addition to the normal program in chemical engineering, the department participates in two interdisciplinary graduate programs. These programs are particularly designed for students who received their previous degree(s) in mathematics, physics, chemistry, or biology, but who have become interested in the engineering applications appropriate to a particular field of interest. In these programs, a graduate student is not expected to be responsible for the broad background in chemical engineering expected in a regular program but, instead, substitutes his background in his own particular field and is responsible for only that part of chemical engineering appropriate to his program. The two programs are:

1. Nuclear Engineering, in cooperation with the Physics Department;
2. Systems Theory, Information Theory, and Process Control, in cooperation with the Electrical Engineering Department.

COURSES

Chemical Engineering 301a. Chemical Engineering Fundamentals (3-0-3).

A first course in the application of chemical engineering principles; the use of basic mathematical concepts, physical laws, stoichiometry, and the thermodynamic properties of matter to obtain material and energy balances for systems undergoing both steady and unsteady state changes.

Chemical Engineering 302b. Separation Processes I (3-0-3).

A systematic treatment of single and multistage contacting operations involving binary and mulicomponent systems. The systems are studied using finite difference calculus when appropriate. The operations discussed include distillation, absorption, leaching, and extraction.

Chemical Engineering 401a. Introduction to Transport Phenomena (3-0-3).

The fundamental principles of heat, mass, and momentum transport applied to the continuum; the analysis of macroscopic physical systems based on the continuum equations.

Chemical Engineering 402b. Special Topics in Transport Phenomena (3-0-3).

A detailed treatment of special topics in transport phenomena. Topics include flow of ideal fluids, boundary-layer theory, conduction and convection of heat, and mass transfer.

Chemical Engineering 443a, b. Chemical Engineering Laboratory (0-3-1, each sem.).

Principles of staged processes and transport phenomena are illustrated through experiment. A report is required on each experiment.

Chemical Engineering 501a. Rate Processes (3-0-3).

The derivation of the equations of change for a continuum fluid. Analysis of mass, momentum and heat transport problems using the general transport equations.

Chemical Engineering 502b. Advanced Rate Processes (3-0-3).

A study of recent advances in the theory of transport processes; the application of current techniques to the solution of engineering transport problems.

Chemical Engineering 503a, b. Simulation and Design of Chemical Engineering Processes (3-0-3)a, (3-3-4)b.

A synthesis course applying the principles of staged processes, transport phenomena and chemical kinetics to the simulation, optimal design, and optimal operation of equipment and processes. The second semester includes a computation laboratory.

Chemical Engineering 511a. Thermodynamics I (3-0-3).

An advanced treatment of the laws of thermodynamics. Thermodynamic behavior of pure and multicomponent fluids. Chemical and physical equilibrium in multicomponent systems.

Chemical Engineering 512b. Thermodynamics II (3-0-3).

Special applications of the equilibrium concept to systems involving gravitational, surface, or electrical effects. A detailed study of nonideal solutions. Selected problems and topics in thermodynamics.

Chemical Engineering 517. Fundamentals of Nonlinear Systems (3-0-3).

Intrinsic properties of nonlinear deterministic and random systems including stability, observability and controllability. An introduction to approximation theory and its application to nonlinear estimation. Also offered as Electrical Engineering 517 and Economics 527.

Chemical Engineering 518. Fundamentals of Optimization Theory (3-0-3).

A discussion of the mathematical problems encountered when searching for the best element in a given set. Existence and nonexistence of extrema. Introduction to linear, nonlinear, and dynamic programming, combinatorial problems, variational calculus, and optimal control theory. Also offered as Electrical Engineering 518 and Economics 528.

Chemical Engineering 519. Advanced Mathematical Programming (3-0-3).

Theory, computational methods, and applications of various advanced pro-

gramming models are discussed. Topics include: nonlinear programming; Kuhn-Tucker theory; integer programming; network models; programming models subject to stochastic influences. Understanding of the simplex method is assumed. Prerequisites: E.E. 518 or Economics 445 or equivalent. Also offered as Economics 529 and Electrical Engineering 519.

Chemical Engineering 531a. Nuclear Engineering (3-0-3).

An introductory course in nuclear properties, nuclear reactions, radioactive decay, and fission reactions; theory and design of nuclear reactions using the one group model, the Fermi age treatment, and neutron diffusion; nuclear processing, waste disposal, and health physics.

Chemical Engineering 532b. Nuclear Engineering (3-0-3).

A continuation of Chemical Engineering 531 with a more advanced treatment of nuclear reactor theory using the two-group and multigroup methods and neutron transport theory; calculations for time-dependent reactor operations, temperature and heat transfer effects in a reactor, reactors with reflectors and breeder reactors; a more detailed consideration of the related topics of fuel cycles, isotope separation, and shielding.

Chemical Engineering 543a, b. Advanced Projects Laboratory (0-3-1, each sem.).

Individual and group projects under the direction of various members of the staff. A comprehensive report is required at the end of each semester.

Chemical Engineering 551a or b. Separation Process II (3-0-3).

A quantitative study of multistage calculations for multicomponent systems: analog and digital computer solutions of separation problems; the development of mathematical models for real stages.

Chemical Engineering 560a or b. Heterogeneous Equilibrium and the Phase Rule (3-0-3).

Heterogeneous equilibrium in pure, binary, and multicomponent systems is studied from the standpoint of the phase rule of Gibbs over extreme ranges of pressures and temperatures. General thermodynamic principles are introduced whenever possible.

Chemical Engineering 575a or b. Process Dynamics (3-0-3).

Development of dynamic equations for discrete and continuous models of chemical systems. Linearization techniques applied to control problems in chemical processes. Simulation techniques using analog and digital computers. Stability and phase plane analysis of nonlinear systems.

Chemical Engineering 590a or b. Chemical Reaction Kinetics (3-0-3).

Study of rates of elementary reactions; the kinetics of complex reaction systems; interactions between chemical rates and transport phenomena; theory of chemical reactors.

Chemical Engineering 610. Models in Systems Theory (3-0-3).

The art of developing appropriate mathematical models for systems is introduced by the study of examples selected from a wide variety of fields. Both deterministic and stochastic models are considered. The special assumptions, parameters, and empirical data required for each model are discussed. Factors influencing the choice of a model for any specific problem are identified and illustrated. Some attention is given to the types of mathematical problems posed by various models, but primary attention is directed to the formulation of problems through the development of suitable models.

Chemical Engineering 662a, b. Graduate Seminar (1-0-1, each sem.).

Chemical Engineering 670a, b. Special Topics in Applied Mathematics (3-0-3, each sem.).

Special topics in applied mathematics applied to chemical engineering problems.

Chemical Engineering 683a, b. M.S. Research and Thesis.

Chemical Engineering 685a or b. Molecular Theory of Fluids (3-0-3).

The application of the molecular theory of fluids to calculation of fluid properties. Discussions include the kinetic theory of gases and the statistical mechanics of fluids.

Chemical Engineering 690a or b. Kinetics and Catalysis (3-0-3).

Chemical reaction rates, reaction mechanisms, theories of catalysis, diffusion in porous solids.

Chemical Engineering 691a or b. Chemical Reaction Engineering (3-0-3).

Application of transport theory to chemically reactive multicomponent fluids. Emphasis is on transient behavior of two-phase flowing systems, as in chromatography.

Chemical Engineering 720a or b. Advanced Topics in Chemical Engineering. (3-0-3).

Chemical Engineering 783a, b. Ph.D. Research and Thesis.

Civil Engineering

Professors W. J. Austin, Krahl, Sims, and Veletsos, *Chairman*
Associate Professors Holt, McDonald, and Merwin
Assistant Professors Jirsa, Lutes, and Vann

The profession of civil engineering is concerned with the development, planning, design, construction, and operation of the large facilities and systems which help improve man's environment and contribute to his safer and more enjoyable living. These facilities include:

a) structures of various forms, such as bridges, buildings, industrial plants, stadiums, towers, dams, docks, marine platforms, oil drilling rigs, missile bases, launching platforms for space vehicles, the great antennas that have been constructed for space communication and space research, and the space platforms that may be expected in the future;
b) transportation systems, such as highways, railroads, airfields, canals, harbors, and pipelines;
c) systems for water supply, hydropower, irrigation, drainage, flood control, and navigation; and
d) systems for waste disposal, and for air and water pollution control.

The planning of new communities and the redevelopment of existing cities are also within the spectrum of civil engineering activities.

Undergraduate Program. The general requirements for Civil Engineering degrees are described on pages 00-00. Students contemplating a major in civil engineering should take Engineering 200, 211, 212, 240 and 241 as part of their electives in the Sophomore year. However, schedule adjustments may be made in following years to permit those students who do not take all of these courses as Sophomores to major in civil engineering without the need of taking additional courses.

The undergraduate curriculum is designed to provide a sound basis for future professional growth. The emphasis during the first four years is on mathematics and the engineering sciences, especially solid mechanics, fluid mechanics, and materials. After successful completion of four years of study, a student receives a Bachelor of Arts degree with a civil engineering major. He may then qualify for a fifth year of study leading to the professional degree of Master of Civil Engineering. The fifth year of study is devoted primarily to civil engineering subjects. Through the provision of numerous electives in the fourth and fifth years, the student may obtain some degree of specialization in one of the following technical areas: structural engineering and mechanics, soil mechanics and soils engineering, or environmental engineering. The course requirements for each year of study may be obtained from the departmental office. The detailed program of each student is formulated in consultation with his advisor.

Students with special interest in research may, upon recommendation of the Department and approval of the Graduate Council, enter a program leading to the Master of Science degree directly after completing the requirements for the Bachelor of Arts degree.

Graduate Program. The primary strength of the graduate program in civil engineering is in the fields of structural engineering and applied mechanics although graduate work is also offered in soil mechanics and soils engineering. The program emphasizes the scientific fundamentals of these disciplines; it is designed to develop strength in depth and the ability to keep abreast of the technical developments that may be expected in the years ahead. Special attention is given to promoting the student's interest in and ability for independent study and research. The programs of study offered can lead to the degrees of Master of Civil Engineering, Master of Science, and Doctor of Philosophy. University requirements for these degrees are outlined on pages 99-104.

A candidate for the Master of Civil Engineering degree is required to complete ten semester-courses, of which two must be in the social sciences or humanities. A candidate for the Master of Science degree is required to complete the equivalent of seven semester-courses and an acceptable thesis. Candidates for the degree of Doctor of Philosophy must satisfy the following requirements: complete the equivalent of sixteen semester-courses with high standing; pass a comprehensive

qualifying examination designed to test the candidate's knowledge of his field and his ability to think in a creative manner; complete a thesis which shall constitute an original contribution to knowledge; and pass a final oral examination on the thesis and related topics. In addition, he must demonstrate a reading knowledge of one foreign language, usually French, German, or Russian.

The research interests of the members of the civil engineering faculty are in the areas of structural dynamics, plate and shell structures, numerical analysis and computer utilization, plasticity, concrete technology, and soil mechanics and soils engineering.

The recently completed Ryon Engineering Laboratory provides a modern facility for research in the above areas. The computer facilities are ample for undergraduate and graduate instruction and research. They include an IBM 1620, the Rice computer, and an IBM 7040.

COURSES

Civil Engineering 300. Introduction to Mechanics of Solids (3-0-3).

Stresses and deformations due to tensile, compressive, and shearing forces, bending moments, and torque. Consideration of beams, columns, shafts, pressure vessels, axially-loaded members, members with combined loadings, determinate and indeterminate structural systems. Study of engineering properties of materials and failure theories. Prerequisite: Engineering 211 or equivalent. *Mr. Merwin*

Civil Engineering 302. Structural Analysis I (3-0-3).

Analysis of statically determinate beams, frames, trusses, and funicular structures, including space structures. Influence lines. Approximate analysis of statically indeterminate structures. Prerequisite: Engineering 211.

Civil Engineering 350. Engineering Measurements and Surveying (3-3-4).

Theory of measurements in general, including types of errors, distribution of errors, measures of precision, the principle of least squares, propagation of errors, and dimensional analysis. Application of these concepts in elementary surveying and route surveying. Geometric design of highways, considering horizontal and vertical curves, earthwork, and safety. Laboratory fee required. *Mr. Vann*

Civil Engineering 403. Structural Analysis II (3-0-3).

Basic theorems of structural analysis. Deflections of beams and trusses. Classical methods of analysis of statically indeterminate trusses, beams, and framed structures. Influence lines for statically indeterminate structures. Prerequisites: Civil Engineering 300 and Civil Engineering 302.

Civil Engineering 431. Concrete Laboratory (0-3-1).

Properties of constituent materials of concrete. Design and control of concrete mixtures. Properties of concrete and reinforcing steel. Laboratory tests of reinforced concrete members, including beams in flexure, beams in combined shear and flexure, and columns. Laboratory fee required. *Messrs. Jirsa and Krahl*

Civil Engineering 432. Design of Reinforced Concrete Structures (3-0-3).

Design of structural members and frameworks of reinforced concrete. Working stress and ultimate strength design. Introduction to prestressed concrete. Design of typical parts of buildings, bridges, and foundations. *Mr. Krahl*

Civil Engineering 434. Design of Metal Structures (3-0-3).

Design of tension members, compression members, beams, and connections. Design of plate girders, roof trusses, simple bridge trusses, and building frames. Introduction to plastic design of steel structures. *Mr. Krahl*

Civil Engineering 450. Transportation (3-0-3).

Transportation as an overall system for moving persons and goods. Important considerations in planning, designing and operating such major constituents of a transportation system as streets and highways, airports, railways and waterways. *Mr. Lutes*

Civil Engineering 460. Mechanics of Fluids (3-0-3).

Fundamentals of fluid mechanics, including properties of fluids, fluid statics, flow concepts, viscous effects, dimensional analysis, dynamic similitude, and two-dimensional ideal fluid flow. Engineering applications. *Mr. Merwin*

Civil Engineering 461. Hydrology and Water Resources Engineering (3-0-3).

Principles and design of water collection, transmission, and distribution systems, including hydrology, reservoirs and dams, and open-channel and conduit trasmission systems. Control and use of water resources, including irrigation, municipal and industrial water supply, river navigation, drainage, flood prevention, and sewage disposal. Prerequisite: Civil Engineering 460 or equivalent. *Mr. Austin*

Civil Engineering 470. Soil Mechanics and Foundation Engineering I (3-3-4).

A comprehensive introductory course. Geological origins and classification of soils and their hydraulic, strength, and compressibility characteristics. Stress distribution in soils, bearing capacity of shallow and pile foundations, lateral earth pressure, slope stability. Field exploration procedures. All the standard tests are performed in the laboratory. Laboratory fee required.

Civil Engineering 490. Civil Engineering Professional Practice (3-0-3).

A course to acquaint the students with the professional aspects of engineering works-project financing, elements of contracts and specifications, discussion of A.I.A., A.S.C.E., and A.G.C. agreement forms, manuals of professional practice. Offered on demand. *Mr. Sims*

Civil Engineering 491. Senior Laboratory I (0-3-1).

This course provides laboratory instruction in several disciplines of interest. Selected experiments in the fields of thermodynamics, fluid mechanics, strength of materials, and material science are performed. Laboratory fee required. Offered jointly as Mechanical Engineering 406. *Messrs. Merwin and Plapp*

Civil Engineering 492. Senior Laboratory II (0-3-1).

Continuation of Civil Engineering 491. Laboratory fee required. This course is offered jointly as Mechanical Engineering 407. *Messrs. Merwin and Plapp*

Civil Engineering 500. Advanced Mechanics of Solids (3-0-3).

Advanced topics in stress analysis. Three-dimensional states of stress and strain; theories of failure of elastic action; shear center; unsymmetrical bending; curved beams; beams on elastic supports; flat plates; torsion of noncircular sections; column theory; local buckling; lateral buckling; stress concentration; plastic analysis. Properties of metals. *Mr. Merwin*

Civil Engineering 503. Structural Analysis III (3-0-3).

Matrix methods of structural analysis. Flexibility and stiffness of structural elements. Equations of compatibility and equilibrium. Force and displacement methods of analysis. Nonlinear structures; arches and suspension bridges. Prerequisite: Civil Engineering 403 or equivalent. *Mr. Holt*

Civil Engineering 504. Numerical Methods of Structural Analysis (3-0-3).

Numerical methods for the solution of complex structural engineering problems. Newmark procedure for the analysis of beams, beam-columns, and beams on elastic foundations and for the determination of buckling loads and natural frequencies. Finite difference method for approximate solution of boundary value problems in ordinary and partial differential equations. Numerical procedures for the solution of eigenvalue problems. Methods for the integration of propagation problems. Applications to problems in stress analysis, buckling, dynamic behavior and vibrations. *Mr. Austin*

Civil Engineering 506. Experimental Stress Analysis (2-3-3).

Selected topics from theory of elasticity; strain measurement methods, mechanical and electrical resistance strain gages; grid and Moire techniques; brittle coating methods; photoelastic methods; analogies; instrumentation, circuitry and recording instruments; analysis of experimental data. Laboratory fee required.

Civil Engineering 507. Structural Models (2-3-3).

Dimensional analysis, similarity and model laws, derivation of model laws from differential equations, direct and indirect models, design and construction of structural models, characteristics of suitable materials, laboratory measurements and interpretation of results. Laboratory fee required. *Mr. Krahl*

Civil Engineering 520. Structural Dynamics I (3-0-3).

Free vibration, forced vibration, and transient response of linear systems having from one to an infinite number of degrees of freedom; response spectra for undamped and damped systems subjected to exciting forces and ground motions; formulation of problems in matrix form; modal analysis; approximate methods of computation of natural frequencies and modes; applications to design. *Mr. Veletsos*

Civil Engineering 531. Behavior of Reinforced Concrete Members (3-0-3).

Properties of concrete and reinforcing steel. Behavior of reinforced concrete members under various loadings from first application of load to ultimate load. Study of sections subjected to pure flexural and axial loads, combined bending and axial load, combined shear and flexure, and torsion. Bond and anchorage problems. Evaluation of design specifications according to results of research and engineering practice. *Messrs. Jirsa and Krahl*

Civil Engineering 532. Prestressed Concrete (3-0-3).

Properties of materials used in prestressed concrete construction under short-time and sustained loads. Methods of prestressing. Strength and behavior of prestressed concrete members subjected to axial, flexural, shear, and torsional forces. Development of design criteria for prestressed concrete members. Special applications of prestress concepts to slabs, continuous structures, tanks and pressure vessels. *Mr. Jirsa*

Civil Engineering 536. Design of Lightweight Structures (3-0-3).

Analysis and design of structures and structural members of minimum weight. Offered on demand. *Mr. Sims*

Civil Engineering 570. Soil Mechanics and Foundation Engineering II (3-0-3).

Review of fundamentals. Design of shallow and pile foundations. Analysis of earth slopes and design of earth dams. Design of retaining walls and rigid and flexible pavements.

Civil Engineering 604. Engineering Analysis (3-0-3).

Study of the nature of complex problems in engineering and of the means of obtaining practical solutions. General classifications of physical problems. Methods

for the formulation and solution of equilibrium, eigenvalue, and propagation problems in discrete and continuous systems. Applications primarily to problems in mechanics and structural analysis, including equilibrium, buckling, dynamics, and vibration problems. *Mr. Austin*

Civil Engineering 605. Energy Methods in Applied Mechanics (3-0-3).

Fundamental principles and direct methods of variational calculus. General discussion of basic concepts of mechanics of deformable solid bodies. Principle of virtual work with applications to problems of equilibrium and stability. Derivation of variational principles of mechanics, including stationary potential energy, complementary energy, and Reissner's variational theorem. Applications to equilibrium problems in both small and large deformation theories, and to problems of stability. Variational principles of dynamics with applications. *Mr. Vann*

Civil Engineering 610. Analysis of Plates (3-0-3).

Bending theory of medium-thick plates with applications to the analysis of plates of rectangular, circular, and other shapes. Discussion of various methods of solution. Orthotropic plates and gridworks. Refined theories of plates, effects of in-plane forces, large deflections, limit analysis. *Messrs. Austin and Veletsos*

Civil Engineering 611. Analysis of Shells (3-0-3).

Membrane and bending theory of thin cylindrical shells with applications to the analysis of roof shells, tanks, and pipes. Discussion of approximate theories. Differential geometry of shells. Membrane and bending analyses of shells of revolution and translational shells. *Messrs. Austin and Veletsos*

Civil Engineering 612. General Theory of Shells (3-0-3).

Differential geometry of surfaces. General linear theory of bending of elastic shells of arbitrary shape. Discussion of various approximate theories. Solution of problems of technical interest by exact and approximate methods. Introduction to nonlinear theories and stability problems. Also offered as Mechanical Engineering 627.

Civil Engineering 615. Theoretical Plasticity (3-0-3).

Formation of basic laws of isotropic and anisotropic plastic flow; yield and loading surfaces, normality and convexity requirement, and hardening rules; plane plastic flow problems and slip-line field theory; introduction to limit analysis theorems. Also offered as Mechanical Engineering 628.

Civil Engineering 616. Applied Plasticity (3-0-3).

A study of the mechanics of inelastically deformed bodies; applied limit analysis and limit design; flexure and torsion of prismatic members; axially symmetric problems; shakedown and incremental collapse; elastically contained plastic deformation. Also offered as Mechanical Engineering 629. *Mr. Merwin*

Civil Engineering 620. Structural Dynamics II (3-0-3).

Free and forced vibration of nonlinear elastic and inelastic systems. Approximate methods of analysis, criteria for stability, subharmonic and superharmonic vibrations. Propagation of waves in elastic solids, with special reference to effects of blast and earthquakes. Characteristics of recorded earthquake motions and response of structures to such inputs. Earthquake-resistant design of structures. Introduction to vibration of plates, gridworks, arches and cylindrical shells. Offered in alternate years. Prerequisite: Civil Engineering 520 or equivalent. *Mr. Veletsos*

Civil Engineering 622. Random Vibration (3-0-3).

The theory of stochastic processes applied to problems of random vibration. Both single-degree-of-freedom and multi-degree-of-freedom systems with stationary and nonstationary vibration are considered. In addition to analyzing linear systems, exact and approximate methods of studying some nonlinear systems are presented. *Mr. Lutes*

Civil Engineering 624. Stress Waves in Solids (3-0-3).

Theory of wave propagation with applications to structural engineering. Topics include waves in an infinite medium, reflection and refraction at a boundary, wave scattering, and dispersion in a bounded medium. Specific applications considered include exact and approximate theories of waves propagating along elastic rods, beams, and plates. *Mr. Lutes*

Civil Engineering 626. Theory of Elastic Stability (3-0-3).

Concept of stability of equilibrium. Classification of mechanical systems, external effects, and stability criteria. Classical buckling problems, with particular reference to flexural and torsional buckling of columns, lateral buckling of beams, buckling of frameworks, arches, and plates. Inelastic buckling. Nonconservative problems. Dynamic buckling. Offered in alternate years. *Mr. Vann*

Civil Engineering 631. Behavior of Reinforced Concrete Structures (3-0-3).

Behavior of reinforced concrete structures under various loadings, with emphasis on ultimate strength. Consideration of statically indeterminate beams and frames. Design and analysis of floor slabs including yield-line theories. Evaluation of building code specifications and discussion of research in reinforced concrete structures. *Mr. Jirsa*

Civil Engineering 634. Behavior of Metal Structures (3-0-3).

A critical evaluation of the behavior of metals, connections, members, and structures; significance of this behavior in terms of design. Interpretation of codes and specifications for the design of bridges and buildings. Offered on demand.

Civil Engineering 670. Advanced Soil Mechanics (3-0-3).

Detailed consideration of compressibility and shear characteristics of cohesive and granular soils. Lateral earth pressures. Advanced theories of stress distribution in soils and bearing capacity of shallow and pile foundations. Seepage. Behavior of soils under dynamic loads. Brief consideration of deformational behavior of rock masses.

Civil Engineering 671. Theoretical Soil Mechanics (3-0-3).

Consideration of stress and strain and the relations of elasticity, viscosity, plasticity, and combinations thereof. Rheology of cohesive and granular soils. Review of recent theories of soil deformation. Solution of complex soil mechanics problems, including use of approximation techniques.

Civil Engineering 699. Special Problems. (Variable credit).

Study of selected topics including individual investigations under the direction of a member of the Civil Engineering faculty. *Staff*

Civil Engineering 700. Research and Thesis.

An original research investigation carried out by the individual student under the direction of a member of the Civil Engineering faculty. *Staff*

A number of courses offered in other Departments are also recommended to students in Civil Engineering. The reader is referred, particularly, to the courses in applied mathematics listed under Engineering and under Mathematics, to the additional courses in mechanics and materials offered in the Department of Mechanical and Aerospace Engineering and Materials Science, and to the courses in systems theory and optimization offered in the Department of Electrical Engineering.

Electrical Engineering

Professors Bourne, *Chairman,* De Figueiredo, Gordon, McEnany, Pfeiffer, and Wischmeyer
Associate Professors Jain, Leeds, Pearson, Rabson and Tittel
Visiting Associate Professors Kusuda and Stanton
Assistant Professors Bahler, Burrus, L. E. Davis, Huband, Jump, Parks, and Sibert
Lecturers Cyprus, MacPhail, and Orvedahl

The first two years of the science-engineering program are described on pages 56-59 of the catalog. Sophomore students contemplating a major in electrical engineering should elect Engineering 200, 240, and 241 and a full year of Physics 210a,b. However, provisions are made in the Electrical Engineering curriculum so that students who fail to take these suggested electives in the Sophomore year may rectify this ommission in the Junior year with appropriate adjustments in their program.

After completing four years of his curriculum, the student receives a Bachelor of Arts degree, with an electrical engineering major. If his achievement is satisfactory, he then qualifies for a fifth year of study leading to the professional degree, Master of Electrical Engineering.

Representative programs showing the normal registration in courses for each year leading to the degree of Bachelor of Arts and Master of Electrical Engineering are available from the department. These programs are flexible and may be adjusted to suit the individual interests and needs of the student.

Qualified students may, upon recommendation of the department and approval of the Graduate Council, enter a program leading directly to the Master of Science degree after completing the Bachelor of Arts degree.

Requirements of a general nature for advanced degrees are outlined on pages 99-104. Students should consult the department advisers for specific courses of study.

A candidate for the Master of Science degree in the Electrical Engineering Department is required to complete an approved course of study. In addition, he is required to complete an approved research program and submit an acceptable thesis. A semester or more of supervised teaching is considered a valuable part of graduate education.

The granting of the degree of Doctor of Philosophy presupposes high quality academic work and demonstrated ability to do independent and creative research. To be admitted to candidacy, the student must show promise of realizing these goals by obtaining high standing in an approved course program and by performing satisfactorily on qualifying examinations designed to test his grasp of fundamen-

tals as well as his ability to think independently. Normally, the candidate completes the requirements for a Master's degree as part of his program. The candidate must satisfy the department language requirement and participate in a program of supervised teaching. Emphasis is placed on the research leading to a satisfactory dissertation. Each candidate takes a final oral examination, as described on page 101. The doctoral candidate should expect to devote, as a minimum, the equivalent of three full academic years of graduate study in this program.

Regular graduate programs in electrical engineering include the general areas of systems and control theory, communications and information theory, active and passive networks, computers, solid-state and physical electronics, electromagnetic theory, and bioengineering. In addition to the regular graduate programs, there are four special graduate programs particularly designed for those who received their previous degree(s) in mathematics, physics, chemistry, or the other sciences, including undergraduate engineering science programs, but who have become interested in the engineering applications appropriate to a particular field of science. These programs exist in the areas of systems theory, solid-state electronics and materials science, computer science, and bioengineering.

In the following list a course program in a given area contains courses in the 300-series, 400-series, 500-series, and 600-series. Courses in a given area are identified by the second digit in the number.

COURSES

Electrical Engineering 301. Fundamentals of Network Analysis (3-4-4).

Network equations and topology. State equations of networks: formulation and solution. Concepts of modes, stability, excitability, observability. Input-output relations using exponential excitations; transfer functions, n-ports. Relations of eigenvalues, poles, modes, and frequency response. Prerequisite: Engineering 241. Laboratory fee required.

Electrical Engineering 305. Electromagnetic Field Theory (3-0-3).

Review of vector analysis. Electrostatics. Magnetostatics. Boundary-value problems. Electromagnetic induction. Maxwell's equations and plane waves. Prerequisites: Physics 210a,b.

Electrical Engineering 342. Electronic Circuits (3-4-4).

Low-pass, band-pass, and compensated amplifier stages. Power amplifiers, multistage amplifiers. Biasing of transistors. Feedback amplifiers and oscillators. Electronic instrumentation. Prerequisites: Electrical Engineering 301 and Mathematics 300a. Laboratory fee required.

Electrical Engineering 401. Linear System Theory (3-4-4).

A unified study of signals and linear systems. Signal analysis is based on the Fourier, Bilateral Laplace, and Z Transforms. Input-output analysis of systems is based on the convolution integral. The state variable formulation is developed and related to transfer functions.

Electrical Engineering 403. Magnetic Circuits and Machines (3-4-4).

Energy in magnetic and dielectric systems; linear magnetic circuits and trans-

formers; nonlinear magnetic circuits and magnetic amplifiers; priciples of electromechanical energy conversion, rotating machinery, and transducers. Laboratory fee required.

Electrical Engineering 406. Electromagnetic Wave Propagation (3-0-3).

Transmission lines. Plane waves. Plane interfaces. Guided waves. Rectangular and circular waveguides. Microwave resonant cavities. Radiation. Linear antennas and simple arrays. Prerequisite: Electrical Engineering 305.

Electrical Engineering 415. Control Systems I (3-4-4).

Introduction to the design of feedback control systems. Description of typical control system components. Stability of linear and nonlinear systems. Analysis and design of control systems in the frequency domain. Optimization of linear systems. Hybrid systems. Laboratory projects will be assigned on the representation, design and testing of a system. Prerequisite: Electrical Engineering 401.

Electrical Engineering 420. Pulse and Digital Circuits (3-4-4).

Oscillators, timing circuits, counters. Bistable, monostable, and astable circuits. Diode gates and selection matrices. Trigger circuits and blocking oscillators. Emphasis is placed upon discrete component solid state technology. Prerequisite: Electrical Engineering 342. Laboratory fee required.

Electrical Engineering 421. Digital System Components (3-4-4).

Organization of digital computers. Number systems, arithmetic and control units, input-output equipment. Logic implementation, applications of Boolean algebra, logic partitioning, printed circuit technology. Emphasis is placed upon application of integrated circuits. The class participants will design and build an operational digital system in lab during the semester. Prerequisite: Electrical Engineering 420. Laboratory fee required.

Electrical Engineering 430. Introduction to Statistical Communication Theory (3-0-3).

Analysis and parameter estimation of random sequences and processes. Evaluation of standard modulation schemes in the presence of additive noise. Relationship of signal-to-noise ratio to maximum likelihood performance criteria. The Gaussian process and its special status. Prerequisite: Engineering 475, Electrical Engineering 401.

Electrical Engineering 442. Advanced Electronic Circuits (3-0-3).

Electronic circuits used in communication and other systems including principles of feedback, modulation, detection, and active filtering. Emphasis is placed on design using integrated circuits. Prerequisite: Electrical Engineering 342.

Electrical Engineering 460. Introduction to Quantum Mechanics (3-4-4).

Experimental foundations of quantum mechanics; solutions of Schroedinger's equation for the harmonic oscillator and the hydrogen atom; the exclusion principle; the hydrogen molecule; metallic binding; behavior of an electron in a periodic potential; the band theory of solids; quantum statistics. Prerequisite: Electrical Engineering 305. Laboratory fee required.

Electrical Engineering 461. Electrical Properties of Materials (3-0-3).

Atomic and crystal theory of electrical engineering materials. Properties and parameters of magnetic, dielectric, conducting, and semiconducting materials important in the understanding of device characteristics.

Electrical Engineering 462. Solid-State Devices (3-4-4).

A study of some of the important solid-state electronic devices, particularly semiconductor and ferromagnetic devices. Laboratory fee required.

Electrical Engineering 493. Electrical Engineering Projects (Credit to be arranged).

Theoretical and experimental investigations under staff direction.

The following courses are normally open only to students engaged in a program leading to an advanced degree.

Electrical Engineering 502. Network Synthesis (3-0-3).

A study of both the theoretical and practical aspects of network synthesis. Emphasis will be on linear, passive electrical networks. Topics covered include: realizability, one-port synthesis, approximation methods, two-port synthesis and filter design, n-port theory, and selected topics of current interest.

Electrical Engineering 505. Advanced Electromagnetic Field Theory (3-0-3).

The mathematical techniques involved in field theortical calculations: Green's functions, variational methods, integral transforms, wave propagation through periodic structures, interaction of fields with charged particles.

Electrical Engineering 506. Applications of Electromagnetic Field Theory (3-0-3).

Applications of electromagnetic theory to plasma physics, microwave techniques, antennas and radiation of electromagnetic waves, ferrites, and quantum electronics.

Electrical Engineering 507. Nonlinear Analysis (3-0-3).

This course presents various nonlinear systems and the basic methods of nonlinear analysis. Topics covered are: basic numerical methods, phase-plane, singular point analysis, limit cycles, stability, elliptic functions, perturbations, averaging, describing functions, and certain time-varying linear problems. Also offered as Mechanical Engineering 507.

Electrical Engineering 517. Fundamentals of Nonlinear Systems (3-0-3).

Intrinsic properties of nonlinear deterministic and random systems including stability, observability and controllability. An introduction to approximation theory and its application to nonlinear estimation. Also listed as Chemical Engineering 517, and Economics 527.

Electrical Engineering 518. Fundamentals of Optimization Theory (3-0-3).

A discussion of the mathematical problems encountered when searching for the best element in a given set. Existence and nonexistence of extrema. Introduction to linear, nonlinear, and dynamic programming, combinatorial problems, variational calculus, and optimal control theory. Also listed as Chemical Engineering 518 and Economics 528.

Electrical Engineering 519. Advanced Mathematical Programming (3-0-3).

Theory, computational methods, and applications of various advanced programming models are discussed. Topics include: nonlinear programming; Kuhn-Tucker theory; integer programming; network models; programming models subject to stochastic influences. Understanding of the simplex method is assumed. Also listed as Chemical Engineering 519 and Economics 529. Prerequisites: Electrical Engineering 518 or Economics 445 or equivalent.

Electrical Engineering 521. Digital System Design (3-0-3).

The principles of digital system design will be studied, as they pertain to computing instruments and to programming systems. Contemporary computing systems will be examined.

Electrical Engineering 522. Automata and Programming Theory (3-0-3).

A general investigation of algorithmic processes. Topics considered will include the relation between algorithms and recursive function theory; the characterization, properties and capabilities of Turing machines and other abstract automata; and concepts and methods of algorithmic programming, including languages for the description of algorithms.

Electrical Engineering 534. Statistical Signal Detection (3-0-3).

Statistical theory of signal detection and its implications for signal design. Topics include the detection of narrow-band signals in communication systems, the resolution of radar signals, design of radar signals, and the selection of signals for communication channels. Prerequisite: a knowledge of Random Processes, Fourier Transforms.

Electrical Engineering 535. Information Theory (3-0-3).

A discussion of the problems posed by an information theoretic approach to digital communications, and a development of the analytic tools necessary to solve these problems. A basic knowledge of both algebra and probability is assumed. Prerequisite: Electrical Engineering 430, 534.

Electrical Engineering 562. Microwave Engineering (3-4-4).

Review of waveguides and resonant cavities. The scattering matrix and applications to 2-, 3- and 4-port devices. Principles of broadband transformers, couplers, and filters. Microwave generation. Tensor susceptibility and nonreciprocal devices. Prerequisite: Electrical Engineering 406. Laboratory fee required.

Electrical Engineering 563. Introduction to the Solid-State (3-0-3).

This course will provide an introduction to the fundamental concepts about crystalline solids, and provide the basic preparation for further courses in the sequence EE 564-567. It will consist of the following: a brief review of Quantum Mechanics and Statistical Mechanics, a discussion of crystal structure, a study of the diffraction of waves by lattices and an introduction to the concept of the reciprocal lattice, classical and quantum-mechanical descriptions of lattice vibrations and the thermal properties of insulators, and the properties of electrons in solids including free-electron and band-theoretical approaches. Prerquisites: An introductory background in wave mechanics and statistical mechanics, and concurrent enrollment in a graduate level quantum mechanics course is assumed. Also listed under same number in Departments of Chemistry, Mechanical Engineering and Physics.

Electrical Engineering 564. Electron Transport and Superconductivity (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow EE 563. It will consider various aspects of electron transport, primarily from a microscopic viewpoint. Among topics to be covered will be various contributions to electron scattering and some techniques for measuring the Fermi Surface. In addition, an introduction to superconductively will be presented. Prerequisite: EE 563 or equivalent. Also listed under same number in Departments of Chemistry, Mechanical Engineering and Physics.

Electrical Engineering 565. Dielectric & Optical Properties of Matter (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow EE 563. Topics included are: polarization and the static model of a dielectric medium in an electric field; extension of the above model to the dynamic case and dielectric dispersion in solids; Raman and Brillouin scattering; Optical spectra of solids; stimulated effects with applications to lasers; the dynamics of the nonlinear interaction between radiation and matter. Prerequisites: EE 563 or equivalent. Also listed under same number in Departments of Chemistry, Mechanical Engineering and Physics.

Electrical Engineering 566. Imperfections & Mechanical Properties (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow EE 563. Point defects in crystals, geometrical description of dislocations and the mathematics theory of lattice imperfections will be discussed. Non-thermal generation of point defects, physical observation of defects in crystals and special properties of lattice imperfections in metallic, ionic and homopolar crystals will be covered. How lattice imperfections in ionic, metallic and homopolar crystals affect certain physical properties of these crystals will be developed. The effects of lattice defects, particularly dislocations, upon the mechanical properties of crystals will be discussed. Prerequisites: EE 563, or equivalent. Also listed under same number in Departments of Chemistry, Mechanical Engineering and Physics.

Electrical Engineering 567. Magnetism and Magnetic Resonance (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow EE 563. The basis of the magnetic properties of solids will be discussed. This will include diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, and ferrimagnetism. The phenomenon of magnetic resonance will be studied. This will include nuclear magnetic resonance, electron paramagnetic resonance, and ferromagnetic resonance. The emphasis will be on the atomic origin of magnetism and on a description of the elementary excitations of ordered magnetic materials. Prerequisite: EE 563 or equivalent. Also listed under same number in Departments of Chemistry, Mechanical Engineering and Physics.

Electrical Engineering 580. Introduction to Bioengineering (3-0-3).

This course will provide a quantitative understanding of the properties and interactions of those living systems now accessible to engineering concepts. Emphasis will be placed upon analysis, modeling and instrumentation of biological systems. Subjects covered include membrane phenomena and the nervous system, biological receptors, the dynamics of muscle contraction and the neuromuscular control system, and hemodynamics and the circulatory system.

Electrical Engineering 593. Electrical Engineering Projects (Credit to be arranged).

Theoretical and experimental investigations under staff direction.

Electrical Engineering 616. Control Systems II (3-0-3).

Optimum design of control systems. Numerical methods. Stochastic approximation. State and parameter estimation in stochastic systems. Stochastic optimization of linear systems. Topics in adaptive control. Prerequisite: Electrical Engineering 415.

Electrical Engineering 622. Systems Programming (3-0-3).

Design and implementation of programming systems for digital computers. Storage control and the representation of data structures, compilers and assembly programs. Operating systems for multi-programming, time sharing and interactive systems. The influence of system requirements on hardware configuration.

Electrical Engineering 623. Advanced Digital Components (3-0-3).

Generation and distribution of nanosecond pulses. Structure of high speed arithmetic units. Piped, staged, and streamed data flow. Detailed analysis of particular high speed logic elements. Prerequisite: Electrical Engineering 421 or equivalent.

Electrical Engineering 624. Non-numerical Programming (3-0-3).

Non-numeric applications of digital computers drawn from the current literature will be discussed. These may include theory and practice of mechanical proof construction, searches over finite sets, and the stabilization of real-time programs.

Electrical Engineering 645. Active Circuit Synthesis (3-0-3).

The synthesis of active circuits is developed in detail. Work includes computer aided design and the effect of integrated circuits on design problems.

Electrical Engineering 661. Semiconductor Electronics (3-0-3).

Fundamental theory of semiconductor devices. The material of an introductory course in solid-state theory is assumed. Also offered as Mechanical Engineering 648.

Electrical Engineering 662. Ferromagnetic Theory and Devices (3-0-3).

Theory of magnetism. Magnetostatics. Dynamic behavior of magnetic materials. Magnetic thin films. The material of an introductory course in solid-state theory is assumed. Also offered as Mechanical Engineering 649.

Electrical Engineering 666. Quantum Electronics (3-0-3).

The development of the quantum mechanical techniques necessary to explain such devices as the laser and maser. Energy level of ions and atoms. Interaction of electromagnetic fields with ions and atoms. Microwave masers. Solid state, gaseous, and semiconductor laser operation. Prerequisites: Electric Engineering 560 and 605.

Electrical Engineering 669. Direct-Energy Conversion Devices (3-0-3).

Thermoelectric and thermomagnetic engines, thermionic converters; radiant energy converters; magneto-hydrodynamic converters; fuel cells; ferroelectric energy conversion.

Electrical Engineering 690. Research and Thesis (Credit to be arranged).

Electrical Engineering 691-699. Seminars on Advanced Topics (Credit to be arranged.)

Descriptions published each year in separate memoranda.

Environmental Science and Engineering

Professor Busch, *Chairman*
Associate Professors Leeds and C. H. Ward

The Environmental Science and Engineering Program is an interdepartmental activity and offers the Master of Science and Doctor of Philosophy degrees. Applicants for admission to this interdepartmental program may hold the baccalaureate or masters degree in any of the sciences, mathematics or engineering.

The program serves as the focal point for university-wide study and research in the broad man-environment problem spectrum. The participation of faculty members from the departments of Chemical and Electrical Engineering, Architecture, Biology, Geology, Economics and Psychology indicates the extent of this interdisciplinary activity. Graduate students enrolled in any of these departments and interested in environmental problems for thesis topics may use facilities of the Environmental Science and Engineering Program and are eligible for financial assistance in the form of graduate traineeships.

Candidates for the Master of Science or Doctor of Philosophy degree may pursue a course program designed both to complement and

supplement their background. This is accomplished through major and minor emphasis areas although formal minors are not required. University requirements for the advanced degrees are presented on pages 99-104.

A candidate for the Master of Science degree must complete a minimum of eight approved one-semester courses and present and defend, in oral examination, a research thesis. Normally two academic years and the intervening summer are required for the degree.

A candidate for the degree of Doctor of Philosophy must demonstrate his competence in three areas through qualifying examinations. The areas of competence may be selected as commensurate with the candidate's major and minor course emphases. The thesis must document and be defensible evidence of the candidate's ability to do original research in a specialized phase of Environmental Science and Engineering.

COURSES

The majority of courses taken by students of Environmental Science and Engineering are those offered in other departments.

Environmental Engineering 536a,b. Synthesis of Water Quality Systems I and II (3-0-3 each sem.).

The theory of the operations and processes used in water and waste-water treatment and the synthesis of systems for accomplishment of a specified water-quality objective.

Environmental Science and Engineering 600a,b. Seminar.

Environmental Science and Engineering 641a,b. Advanced Topics (3-0-3 each sem.).

Consideration of new concepts in analyzing problems of the environment. Discussion of current literature from several disciplines of pertinence. Interpretation of current research.

Environmental Science and Engineering 650a,b. Research and Thesis.

Mechanical and Aerospace Engineering and Materials Science

Professors Beckmann, Brotzen, Chapman, *Chairman,* Cheatham, Mackay, Miele, and Wilhoit
Visiting Professor Schoeck
Associate Professors Ingram, Roberts, Rudee, and Wierum
Assistant Professors Bowen, Huang, McLellan and W. F. Walker
Instructor Miller

Requirements for the degrees in Bachelor of Arts with a major in Mechanical Engineering and Master of Mechanical Engineering are summarized on pages 57-59. Representative courses and normal se-

quence of registration in courses during the student's undergraduate years are available from the department.

It is recommended that students contemplating a major in mechanical engineering take Engineering 211a, 212b, Engineering 240a, 241b, and Engineering 200b among their electives in the Sophomore year. However, schedule adjustments may be made in the Junior and Senior years to permit those students who do not take all these courses as Sophomores to major in mechanical engineering without suffering the penalty of taking additional courses.

After completing four years of his curriculum, the student receives a Bachelor of Arts degree with a major in mechanical engineering. Upon application and upon evidence of satisfactory achievement, the student may enter the fifth-year program leading to the professional degree Master of Mechanical Engineering.

Qualified graduates of other universities desiring the additional professional training offered by advanced level course work may apply to the Committee on Professional Master's Degree for admission to the above program leading to the Master of Mechanical Engineering.

Students completing the four-year Bachelor of Arts program, or qualified graduates of other universities, having special interests in research may, upon recommendation of the Department and approval of the Graduate Council, enter the graduate program leading to the Master of Science and Doctor of Philosophy degrees. The general University requirements for these degrees are outlined on pages 99-104. Specific course requirements are variable, depending upon preparation, performance on qualifying examinations, etc., and may be obtained from the Department office.

The research interests of the mechanical engineering faculty and the laboratory research equipment available provide the following areas of specialization: (1) Engineering Mechanics; (2) Materials Science; (3) Fluid Dynamics, Gas Dynamics, Heat Transfer; (4) Aero-astronautics.

COURSES

Mechanical Engineering 313. Advanced Engineering Mechanics (3-0-3).

Continuation of Engineering 211 and 212 with emphasis on applications of energy methods in dynamics. Variational methods are used in the study of particle and rigid-body dynamics, electric circuits, electromechanical systems, and continuous dynamics systems. *Mr. Cheatham*

Mechanical Engineering 380. Introduction to Engineering Statistics and Economics (3-0-3).

An introduction to the analysis of engineering problems by statistical and economic means. Topics discussed include basic probability theory, distributions, statistical decision making and significance tests, regression techniques, analysis of variance, quality control, and interest rate problems.

Mechanical Engineering 381. Industrial Processes Laboratory (0-3-1).

A laboratory providing practical experience in and observation of selected industrial production processes. Laboratory fee required.

Mechanical Engineering 390. Production Metallurgy (3-3-4).

Class and laboratory instruction in the processes utilized in the production of metals. A study is made of the chemistry and thermodynamics of the reactions involved in ore concentration and in the extraction, refining, and alloying of metals. Laboratory fee required.

Mechanical Engineering 395. Materials Science (3-3-4).

An introductory course in the science of solid materials, covering not only metals, but also ceramics, plastics, and semiconductors. The basic understanding of the nature of solid materials will be stressed. The subject matter is approached from both the atomic and macroscopic points of view. Prerequisites: Physics 100a,b, 200a, Chemistry 120a,b. Laboratory fee required. *Mr. Brotzen*

Mechanical Engineering 401. Thermodynamics (3-0-3).

A fundamental and rigorous exposition of the laws of classical thermodynamics. The various deductions that may be made from these laws are discussed and their physical significance is emphasized. Applications of these principles to systems of physical significance in various disciplines are made. Particular attention is directed to the applications of these principles to pure substances and the interrelations between their thermodynamic properties. *Mr. Chapman*

Mechanical Engineering 404. Applications of Thermodynamics (3-0-3).

A course which stresses the applications of classical thermodynamics to systems of particular interest in mechanical and aerospace engineering. Energy conversion systems, refrigeration systems, psychometric principles, and thermodynamic applications in compressible flow are treated. *Mr. Walker*

Mechanical Engineering 405. Dynamics and Thermodynamics of High Velocity Fluid Flow (3-0-3).

An introductory course which deals with the fundamentals of compressible fluid dynamics. A thorough treatment is given to one-dimensional flows with area change, normal shocks, friction, and heat addition. An introduction is made to multidimensional flows with special emphasis on perturbation theory, Prandtl-Meyer flow, and oblique shock waves. *Mr. Walker*

Mechanical Engineering 406. Senior Laboratory I (0-3-1).

This course provides laboratory instruction in several disciplines of interest. Selected experiments are performed in the field of thermodynamics, fluid mechanics, strength of materials, and materials science. Laboratory fee required. Also offered as Civil Engineering 491. *Messrs. Merwin and Plapp*

Mechanical Engineering 407. Senior Laboratory II (0-3-1).

A continuation of Mechanical Engineering 406. Laboratory fee required. *Mr. Plapp*

Mechanical Engineering 483. Mechanical Design (3-0-3).

The application of energy methods, buckling theory, and failure theories to problems of mechanical design. Considered are torsion theory, design of shafts and springs, shrink fits, flywheel problems, and power transmission elements such as cams and gears. Lubrication theory is also included. *Mr. Cheatham*

Mechanical Engineering 501. Seminar I (1-0-1).

A course devoted to the purpose of training engineering students in collecting and presenting orally formal papers on topics of engineering interest. The papers are given by the students, using materials secured from technical periodicals. The course meets weekly and is conducted in the form of a professional society meeting. Required of all mechanical engineering students in the year they are candidates for the Master of Mechanical Engineering. *Staff*

Mechanical Engineering 502. Seminar II (1-0-1).

A continuation of Mechanical Engineering 501.

Mechanical Engineering 507. Nonlinear Analysis (3-0-3).

An introductory study of nonlinear systems and the various methods of analysis. Problems described by first and second order, driven and undriven equations giving rise to nonlinear oscillations and vibrations are covered. The basic topics of analysis are: basic numerical methods, phase-plane method, stability, exact analytical solutions, approximate analytical methods, perturbations, describing function, and certain time-varying linear problems. Also offered as Electrical Engineering 507.

Mechanical Engineering 511. Elements of Continuum Mechanics I (3-0-3).

An introduction to advanced topics in the mechanics of deformable media. Topics include tensor analysis, strain, stress, elasticity, plasticity, and fluid flow.
Mr. Ingram

Mechanical Engineering 512. Elements of Continuum Mechanics II (3-0-3).

A continuation of Mechanical Engineering 511. Topics include variational and energy methods, thermoelasticity, viscoelasticity, irreversible thermodynamics, and finite deformation. *Mr. Ingram*

Mechanical Engineering 521. Energy Conversion Systems (3-0-3).

Applications of thermodynamics to the study of energy conversion systems of various forms, including reciprocating engines, gas turbines, ram jets, liquid- and solid-fuel rocket engines. A detailed treatment of thermochemical equilibrium as applied to the combustion process is given. *Mr. Wierum*

Mechanical Engineering 522. Applied Fluid Mechanics and Fluid Machinery (3-0-3).

Applications of fluid mechanics in mechanical engineering. Drag and lift forces in two- and three-dimensional flows are analyzed. Particular emphasis is placed on steady and nonsteady flow in pipes, gravity wave theories, and fluid machinery.
Mr. Beckmann

Mechanical Engineering 526. Advanced Thermodynamics and Heat Power Laboratory I (0-3-1).

Advanced laboratory work in thermodynamics, heat transfer, and fluid mechanics, consisting of at least one small research project in addition to a number of tests of common items of equipment. Laboratory fee required. *Mr. Plapp*

Mechanical Engineering 527. Advanced Thermodynamics and Heat Power Laboratory II (0-3-1).

A continuation of Mechanical Engineering 526. Laboratory fee required.

Mechanical Engineering 536. Introduction to X-ray Diffraction and Electron Microscopy (3-3-4).

An introduction to the study of crystals by the diffraction of X rays. The theory of diffraction from a lattice is developed and applications to commonly encountered experimental techniques are discussed. In addition, chemical analysis by fluorescence and direct observation of lattice defects by electron microscopy are presented. Laboratory fee required. *Mr. Rudee*

Mechanical Engineering 541. Physical Metallurgy (3-3-4).

A study of the fundamentals of solidification, alloying, and heat treatment. The mechanical and nonmechanical properties of metallic systems are discussed from atomic and electronic theory. Structural changes in metals accompanying various basic forming processes are described. An introduction to the oxidation and corrosion of metals. Laboratory experiments will complement the course work and include experiments for example on X-ray diffraction and resistivity. Laboratory fee required. *Mr. Roberts*

Mechanical Engineering 542. Nonmetallic Materials (3-3-4).

The mechanical and physical properties of nonmetallic materials. Laboratory work usually consists of a semester project in one particular phase of the study of nonmetallic materials or physical metallurgy. Laboratory fee required.
Mr. McLellan

Mechanical Engineering 561. Advanced Metallurgical Laboratory I (0-4-1).

Students whose interest lies primarily in the field of materials and metallurgy are given the opportunity for research in these fields. The students will be able to work on problems of a basic nature. Laboratory fee required. *Staff*

Mechanical Engineering 562. Advanced Metallurgical Laboratory II (0-4-1).

A continuation of Mechanical Engineering 561. Laboratory fee required.

Mechanical Engineering 563. Introduction to the Solid-State (3-0-3).

This course will provide an introduction to the fundamental concepts about crystalline solids, and provide the basic preparation for further courses in the sequence Mechanical Engineering 564-567. It will consist of the following: a brief review of Quantum Mechanics and Statistical Mechanics, a discussion of crystal structure, a study of the diffraction of waves by lattices, and an introduction to the concept of the reciprocal lattice, classical and quantum-mechanical descriptions of lattice vibrations and the thermal properties of insulators, and the properties of electrons in solids including free-electron and band-theoretical approaches. Prerequisites: An introductory background in wave mechanics and statistical mechanics, and concurrent enrollment in a graduate level quantum mechanics course is assumed. Also offered as Chemistry 563, Electrical Engineering 563, and Physics 563.
Staff

Mechanical Engineering 564. Electron Transport and Superconductivity (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow Mechanical Engineering 563. It will consider various aspects of electron transport, primarily from a microscopic viewpoint. Among topics to be covered will be various contributions to electron scattering and some techniques for measuring the Fermi Surface. In addition, an introduction to superconductivity will be presented. Prerequisite: Mechanical Engineering 563 or equivalent. Also offered as Chemistry 564, Electrical Engineering 564, Physics 564. *Mr. Rudee*

Mechanical Engineering 565. Dielectric & Optical Properties of Matter (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow Mechanical Engineering 563. Topics included are: polarization and the static model of a dielectric medium in an electric field; extension of the above model to the dynamic case and dielectric dispersion in solids; stimulated effects with applications to lasers; the dynamics of the nonlinear equivalent. Also offered as Chemistry 565, Electrical Engineering 565, and Physics 565. *Mr. Rabson*

Mechanical Engineering 566. Imperfections & Mechanical Properties (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow Mechanical Engineering 563. Point defects in crystals, geometrical description of dislocations and the mathematical theory of lattice imperfections will be discussed. Non-thermal generation of point defects, physical observation of defects in crystals and special properties of lattice imperfections in metallic, ionic and homopolar crystals will be covered. How lattice imperfections in ionic, metallic and homopolar crystals affect certain physical properties of these crystals will be developed. The effects of lattice defects, particularly dislocations, upon the mechanical properties of crystals will be discussed. Prerequisites: Mechanical Engineer-

ing 563 or equivalent. Also offered as Chemistry 566, Electrical Engineering 566, and Physics 566. *Messrs. Roberts and Estle*

Mechanical Engineering 567. Magnetism and Magnetic Resonance (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow Mechanical Engineering 563. The basis of the magnetic properties of solids will be discussed. This will include diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, and ferrimagnetism. The phenomenon of magnetic resonance will be studied. This will include nuclear magnetic resonance, electron paramagnetic resonance, and ferromagnetic resonance. The emphasis will be on the atomic origin of magnetism, and on a description of the elementary excitations of ordered magnetic materials. Prerequisite: Mechanical Engineering 563, or quivalent. Also offered as Chemistry 567, Electrical Engineering 567, and Physics 567.

Mechanical Engineering 570. Mechanical Vibrations (3-0-3).

Analysis of discrete and continuous vibrating systems. Approximate methods, integral formulations, and transform method solutions. System response to random excitation. *Mr. Cheatham*

Mechanical Engineering 581. Flight Mechanics I (3-0-3).

General principles of kinematics, dynamics, aerodynamics, and propulsion necessary for the analytical developing of the theory of flight paths. Derivation of the equations of motion. Discussion of the properties of the atmosphere. Solution and discussion of problems of quasi-steady flight. *Mr. Miele*

Mechanical Engineering 582. Flight Mechanics II (3-0-3).

Solution and discussion of problems of nonsteady flight. Performance and aerodynamic heating of hypervelocity vehicles. Rocket vehicle performance with and without aerodynamic forces. Multistage rockets. Prerequisite: Mechanical Engineering 656. *Mr. Miele*

Mechanical Engineering 590. Heat Transfer (3-0-3).

A general course of lectures and recitations from text covering a basic study of the laws of heat transfer by conduction, convection, and radiation. *Mr. Chapman*

Mechanical Engineering 593. Mechanical Engineering Problems.

If conditions are favorable, mechanical engineering students may elect at least nine hours a week in approved investigations or design under the direction of a member of the staff. *Staff*

Mechanical Engineering 600. Research and Thesis.

Mechanical Engineering 601-605. Special Topics in Mechanical and Aerospace Engineering and Materials Science (Variable credit).

Mechanical Engineering 607. Advanced Engineering Analysis (3-0-3).

An introduction to the theory of the complex variable and a review of vector analysis with particular emphasis on engineering applications in the field of fluid dynamics, heat conduction, and elasticity. *Mr. Plapp*

Mechanical Engineering 615. Advanced Dynamics (3-0-3).

Dynamics of a particle, dynamics of a system of particles, Hamilton's principle, Lagrange's equations, orbit mechanics, and Hamilton's equations. *Mr. Wilhoit*

Mechanical Engineering 617. Continuum Mechanics I (3-0-3).

Advanced topics in continuum mechanics. Theory of constitutive equations. Theories of fading memory. Thermodynamics of materials with memory. Wave propagation in materials with memory. Prerequisites: Mechanical Engineering 511 and 512. *Mr. Bowen*

Mechanical Engineering 618. Continuum Mechanics II (3-0-3).

Recent developments in continuum mechanics. Typical areas of study are the following: Irreversible Thermodynamics, Theories of Electromagnetic Interaction with General Materials, Theories of Mixtures and Continuum Dislocation Theories. Prerequisite: Mechanical Engineering 617. *Mr. Bowen*

Mechanical Engineering 619. Wave Propagation I (3-0-3).

A survey of the basic problems and solutions for acoustic, elastic, and electromagnetic wave propagation. Topics include reflection and refraction at plane surfaces. Cagniard's method, the response of sytsems of localized sources, surface waves, and wave propagation in anistropic media are also considered. *Mr. Ingram*

Mechanical Engineering 620. Wave Propagation II (3-0-3).

Harmonic and generalized functional analysis. Application is made of transform techniques to the solution of problems concerning wave propagation in stratified media, plates, and cylinders. Diffraction and scattering are considered. A brief survey is made of wave propagation in plasma. *Mr. Ingram*

Mechanical Engineering 625. Theory of Elasticity I (3-0-3).

General analysis of stress and strain (in three dimensions) and stress-strain relation for an elastic continuum. The formulation of boundary-value problems, general theorems, and minimum principles are presented. Application is made to torsion and flexure of cylinders and to plane strain, plane stress, and generalized plane stress. *Mr. Nordgren*

Mechanical Engineering 626. Theory of Elasticity II (3-0-3).

Muskhelishvili's method and conformal mapping for two-dimensional elastostatic problems. Special formulation of three-dimensional problems, solutions by Green's function and transform techniques are presented. Thermoelasticity, variational theorems, and related approximate methods are included. Prerequisite: Mechanical Engineering 625. *Mr. Nordgren*

Mechanical Engineering 627. General Theory of Shells (3-0-3).

Differential geometry of surfaces. General linear theory of bending of elastic shells of arbitrary shape. Discussion of various approximate theories. Solution of problems of technical interest by exact and approximate methods. Introduction to non-linear theories and stability problems. Also offered as Civil Engineering 612.

Mechanical Engineering 628. Thoretical Plasticity (3-0-3).

Formulation of basic laws of isotropic and anisotropic plastic flow; yield and loading surfaces, normality and convexity requirement, and hardening rules; plane plastic flow problems and slip-line field theory; introduction to limit analysis theorems. Also offered as Civil Engineering 615.

Mechanical Engineering 629. Applied Plasticity (3-0-3).

A study of the mechanics of inelastically deformed bodies; applied limit analysis and limit design; flexure and torsion of prismatic members; axially-symmetric problems; shakedown and incremental collapse; elastically contained plastic deformation. Also offered as Civil Engineering 616.

Mechanical Engineering 634. Thermodynamics of Alloys (3-0-3).

A discussion of classical thermodynamics, the thermodynamic parameters characterizing liquid and solid solutions. Review of quantum and classical statistical mechanics, statistics of lattice interactions, magnetic systems, and vapors. Statistical mechanical treatment of phase equilibria. , *Mr. McLellan*

Mechanical Engineering 635. Transformations in Alloys (3-0-3).

Diffusion theory and the calculation of correlation coefficients for simple lattices. Thermal, self, and solute diffusion through metallic and ionic lattices. Diffusion-controlled transformations. Precipitation from supersaturated solid and liquid solu-

tions. Order-disorder transformations. Shear transformations. Transformations occurring in the heat treatment of iron alloys. *Mr. McLellan*

Mechanical Engineering 636. Diffraction in Nonideal Crystals (2-3-3).

A course describing some of the techniques available for the study of defects in crystals by diffraction methods. Topics covered include diffraction contrast in electron microscopy, the analysis of the structure of deformed metals, and the detection of departures from randomness in solid solutions. Prerequisite: Mechanical Engineering 536. *Mr. Rudee*

Mechanical Engineering 644. Lattice-Imperfection Theory (3-0-3).

Dislocations in otherwise perfect media: the geometry of dislocations in a continuum, their stress fields, and interactions. Dislocations in real crystals (dislocation reactions, dislocation interaction with other crystal imperfections) and theories concerning the origin of dislocations. The presence and behavior of lattice vacancies and interstitials in solids. Production of these defects by different methods including irradiation. *Mr. Roberts*

Mechanical Engineering 645. Mechanical Metallurgy (3-0-3).

Elastic, plastic, and viscous behavior of metallic solids. The interpretation of mechanical behavior in terms of lattice-imperfection theory. Discussion of fracture, fatigue, creep, and damping in metals. Prerequisite: Mechanical Engineering 644. *Mr. Roberts*

Mechanical Engineering 648. Semiconductor Electronics (3-0-3).

Fundamental theory of semiconductor devices. The material of an introductory course in solid-state theory is assumed. Also offered as Electrical Engineering 661.

Mechanical Engineering 649. Ferromagnetic Theory and Devices (3-0-3).

Theory of magnetism. Magnetostatics. Dynamic behavior of magnetic materials. Magnetic thin films. Magnetic tape cores. Device characteristics. The material of an introductory course in solid-state theory is assumed. Also offered as Electrical Engineering 662.

Mechanical Engineering 654. The Calculus of Variation in Engineering (3-0-3).

Ordinary theory of maxima and minima. Calculus of variations in one independent variable. Calculus of variations in two independent variables. *Mr. Miele*

Mechanical Engineering 655. Aerospace Applications of the Calculus of Variations (3-0-3).

Optimum aerodynamic shapes at supersonic, hypersonic, and free-molecular flow velocities. Optimum trajectories for atmospheric flight. Optimum trajectories for extra-atmospheric flight. Prerequisite: Mechanical Engineering 654. *Mr. Miele*

Mechanical Engineering 660. Spacecraft Temperature Control Systems (3-0-3).

A course emphasizing systems analysis and radiation heat transfer in the synthesis of thermal control systems. The material covered will include: the evaluation of the thermal environment in deep space and near planetary bodies; heat transfer from prime and extended surfaces in either radiative or convective environments; design of compact heat exchangers for use within spacecraft and external radiation exchangers; environmental and temperature control systems for manned or unmanned spacecraft; digital computer programs for making parametric studies of systems. *Mr. MacKay*

Mechanical Engineering 661. Spacecraft Power Systems (3-0-3).

A course applying principles of system theory and thermodynamics of power and refrigeration cycles. The material presented includes expendable fluid systems,

fuels cells, energy storage systems, systems utilizing nuclear energy as a heat source, solar power systems, and mechanical refrigeration. Items affecting weight and size of the systems are studied in detail. Parametric methods are used to simplify the analysis. *Mr. MacKay*

Mechanical Engineering 670. Advanced Thermodynamics (3-0-3).

A continuation of the study of the principles of thermodynamics, including a thorough review of the fundamental concepts and laws, a detailed consideration of energy and its transformations and of equilibrium, and introduction to chemical thermodynamics and statistical mechanics. *Mr. Plapp*

Mechanical Engineering 673. Advanced Fluid Dynamics I (3-0-3).

Potential flow and other topics of classical fluid dynamics are extended to airfoil theory, ducted flow and free jets, and open-channel flow. *Mr. Beckmann*

Mechanical Engineering 674. Advanced Fluid Dynamics II (3-0-3).

This course emphasizes flow of viscous fluids. Primary attention is given to boundary-layer flow and to turbulent flow. *Mr. Beckmann*

Mechanical Engineering 675. Special Applications of Fluid Dynamics I (3-0-3).

Geostropic flows in meterology and oceanography are investigated and applied to secondary flow phenomena of laminar and turbulent character. Additional topics of greater interest include ocean wave spectra and their application to the statistics of turbulence. *Mr. Beckmann*

Mechanical Engineering 676. Special Applications of Fluid Dynamics II (3-0-3).

The theory of lubrication and wear, cavitation flow through porous media, transport of solids and gases in fluids, and other phenomena are emphasized. *Mr. Beckmann*

Mechanical Engineering 682. Theory of Convective Heat Transfer (3-0-3).

A thorough investigation of the processes of forced and free convection in laminar and turbulent flow, including a development of the basic equations describing these processes and a presentation of the principal cases for which they have been solved. *Mr. Plapp*

Mechanical Engineering 683. Radiatative Heat Transfer (3-0-3).

A course devoted to the transfer of thermal energy by radiant exchange between surfaces. Radiation properties of surfaces, including monochromatic, specular, and diffuse behavior. General enclosure theory, in the absence of participating gases. *Mr. Chapman*

Mechanical Engineering 691. Advanced Gas Dynamics I (3-0-3).

A detailed study of the physical and mathematical fundamentals of compressible fluid flows. Steady and unsteady flows in one, two, and three dimensions are considered, as well as shock waves and other compressible gas dynamics phenomena. *Mr. Walker*

Mechanical Engineering 692. Advanced Gas Dynamics II (3-0-3).

A continuation of Mechanical Engineering 691. *Mr. Walker*

Mechanical Engineering 696. Viscous Hypersonic Flow (3-0-3).

This course develops the modern theories for laminar and turbulent boundary layers of reactive gas mixtures flowing at hypersonic speeds. *Mr. Wierum*

Mechanical Engineering 697. Hypersonic Gas Dynamics (3-0-3).

The gas dynamic effects which occur in flight at high Mach numbers are studied.

Detailed consideration is given to the theoretical techniques for analyzing hypersonic flows past slender, blunt, and blunt-nosed slender bodies. *Mr. Wierum*

Mechanical Engineering 698. Physical Gas Dynamics (3-0-3).

Both equilibrium and nonequilibrium phenomena in the dynamics of high temperature gases are studies. Emphasis is placed upon the influence of atomic and molecular structure on the dynamical behavior of gaseous systems. *Mr. Wierum*

Mechanical Engineering 699. Gas Dynamics of Radiant Media (3-0-3).

The application of radiative transport theory to the physical problems of gas dynamics is studied. Detailed consideration is given to radiation energy transfer, the interaction of radiant energy with homogeneous matter, and the conservation equations of the gas dynamics of radiant media. *Mr. Wierum*

English

Professors Camden, Dowden, McKillop, Meixner, Parish, Spears, and Ward, *Chairman*
Visiting Professor Jack
Associate Professors Grob, Isle, and Thomas
Assistant Professors Baker, Cox, Doughtie, Kelly, Minter, Morris, and Velz
Lecturers, Barac, Barker, Johnson, and McMurty

Requirements for a Major in English: Thirty-six hours (twelve semesters) in English, two semesters preferably to be English 250a and b, eight to be advanced; at least one semester each of the works of one major English author, English literature before 1700, English literature from 1700 to 1900, American literature, and modern literature; two semesters of advanced courses in French, German, or Latin; four semesters of collateral advanced courses approved by the department.

Requirements for the Degree of Master of Arts. Eight advanced semester-courses in English; the passing of a reading examination in French, German, or Latin; the satisfactory completion of a thesis; the passing of an oral examination. Two years are usually required to complete the work for this degree.

Requirements for the Degree of Doctor of Philosophy. Prospective students are urged to take the Graduate Record Examination at the earliest opportunity and to consult the department well in advance of registration with regard to their qualifications and to the feasibility of their plans for advanced studies in English. The awarding of the doctor's degree is not based on an accumulation of credits; the candidate is expected to show a comprehensive knowledge of the field and to prove his command of the processes and results of scholarship. The following requirements are minimal: sixteen advanced semester-courses in English, including those required for the degree of Master

of Arts; a course in Old English or the history of the English language; the passing of a reading examination in two foreign languages, usually French and German, before taking the preliminary examination; the passing of a preliminary examination, both written and oral, on the general field of English studies; the completion of a thesis which shall constitute an original contribution to knowledge and demonstrate the candidate's power of independent work; the passing of a final oral examination on the thesis and related fields. A graduate student is not admitted to candidacy for this degree until he has passed the preliminary examination.

COURSES

English 100a, b. Introduction to Critical Reading and Writing (3-0-3, each sem.).

Special attention will be given to expository writing and to the study of literary forms. *Staff*

English 240a. Modern and Ancient Narrative in Prose, Verse, and Drama (3-0-3).

Classical and medieval Literature in translation (Homer to Dante). *Mr. Thomas*

English 240b. Modern and Ancient Narrative in Prose, Verse, and Drama (3-0-3).

World narrative (Cervantes to the present, including English and non-English drama, fiction, and verse.) *Mr. Thomas*

English 250a, b. Masters of English Literature (3-0-3, each sem.).

Readings in the major authors representative of the various periods. The backgrounds and a chronological history of English literature will be provided through lectures and supplementary reading. Recommended for all prospective majors in English. *Mr. Grob*

English 260a, b. American Literature (3-0-3, each sem.).

A survey of major American writers and literary movements. Not offered in 1968-69. *Staff*

English 300a. English Drama from the Beginning to Marlowe (3-0-3).

The development of dramatic genres from the "quem quaeritis" to the 1590's in the light of medieval and classical traditions. *Mr. Velz*

English 300b. English Drama from Ben Jonson to the Closing of the Theaters (3-0-3)

A survey of the Jacobean and Caroline dramatists with special emphasis on themes and conventions. *Mr. Velz*

English 310a, b. Modern British Poetry (3-0-3, each sem.).

A survey of British poetry from 1890 to date, with special emphasis on major intellectual developments of the period as they have been reflected in the poetry. *Staff*

English 320a, b. Approaches to Modern Drama (3-0-3, each sem.).

Representative English, Continental, and American plays. (English 320a offered second semester only 1968-69; English 320b not offered 1968-69.) *Mr. Thomas*

English 323a. Auden, Eliot, and Pound (3-0-3). *Mr. Spears*

English 325a. Conrad and His Contemporaries (3-0-3). *Mr. Dowden*

English 325b. Twentieth-Century British Novel (3-0-3).

English 330a, b. Advanced Writing (3-0-3, each sem.).

The writing of essays, stories, plays, and novels. Time is given also to problems of marketing manuscripts. Stories are read and analyzed, and critical theories are discussed. Frequent conferences. *Mr. McMurty and Mr. Williams*

English 340a, b. The English Novel (3-0-3, each sem.).

Major novelists of the eighteenth and nineteenth centuries. (May be taken in either or both semesters.) *Mr. McKillop*

English 350a, b. The Romantic Period (3-0-3, each sem.). *Mr. Dowden*

English 355a. Early Victorian Literature (3-0-3).

Poetry and expository prose of the early Victorian period. Special attention will be given to Carlyle, Tennyson, and Browning. *Mr. Grob and Mr. Thomas*

English 355b. Middle and Late Victorian Literature (3-0-3).

Poetry and expository prose of the middle and late Victorian period. Special attention will be given to Newman, Mill, Ruskin, Arnold, and Hopkins.
Mr. Grob and Mr. Thomas

English 360a. Restoration and Eighteenth-Century Drama (3-0-3).

Not offered in 1968-69.

English 366a. The Earlier Eighteenth Century (3-0-3).

The Augustan Age (1700-1740), with emphasis on Swift and Pope. *Mr. Battestin*

English 366b. The Later Eighteenth Century (3-0-3).

The Age of Johnson (1740-1800), with emphasis on Dr. Johnson and his circle and on the literature of sentiment and sensibility. *Staff*

English 370a. Edmund Spenser and The English Renaissance (3-0-3).
Mr. Doughtie

English 370b. Survey of Sixteenth-Century Literature (3-0-3).

Non-dramatic literature from More through Shakespeare. *Dr. Doughtie*

English 371a. Ballad and Folk-Song (3-0-3).

British and American ballads and folk-songs, their influence on literary poetry, and their social implications. *Mr. Doughtie*

English 371b. The English Lyric Before 1700 (3-0-3).

The lyric as a genre; developments in convention and technique from the Middle Ages through Dryden. *Mr. Doughtie*

English 375a, b. Late Nineteenth-Century and Early Twentieth-Century English Literature (3-0-3, each sem.).

Not offered in 1968-69. *Mr. Thomas*

English 380a. Literature of the Renaissance (3-0-3).
Mr. Parish and Mr. Baker

English 380b. Milton and the Classical Tradition (3-0-3).
Mr. Parish and Mr. Baker

English 385a. Chaucer (3-0-3).

The *Romaunt of the Rose, Book of the Duchess, Troilus and Criseyde;* selections from the *Canterbury Tales.* *Mr. Kelly*

English 385b. Middle English Literature (3-0-3).

Representative works of Middle English drama and lyric poetry; the Alliterative Revival. About one-fourth of the course is devoted to Chaucer. *Mr. Kelly*

English 390a. American Literature to 1850 (3-0-3).

Special attention is given to Whitman, Dickinson, Clemens, and James. *Mr. Ward*

English 390b. American Literature 1850-1900 (3-0-3).

Special attention is given to Whitman, Dickison, Clemens, and James. *Mr. Ward*

English 393a. Twentieth-Century American Fiction (3-0-3).

A survey of main figures from 1900 to the present. Open only to Juniors and Seniors. *Mr. Isle and Mr. Minter*

English 393b. Twentieth-Century American Poetry (3-0-3).

A general survey of poetry in America from 1900 to the present. Open only to Juniors and Seniors. *Mr. Isle and Mr. Minter*

English 395a, b. Life and Literature of the West and Southwest (3-0-3, each sem.).

Not offered in 1968-69. *Staff*

English 400a, b. Shakespeare (3-0-3, each sem.).

A close study of certain of the comedies, histories, and tragedies, with lectures on the interpretation of these plays. (May be taken in either or both semesters.) *Mr. Camden*

English 404a, b. Honors Seminar (3-0-3, each sem.).

Open to students of high standing having a principal interest in English or other modern literatures. Opportunity for independent reading and research will be provided for a selected group who wish to develop individual abilities and significant interests. Papers embodying the results of research will be written. *Staff*

English 440a. History of the English Language (3-0-3).

The structure of Modern English. *Mr. Cox*

English 440b. History of the English Language (3-0-3).

Introduction to methods in historical linguistics via Old and Middle English. (440a prerequisite) *Mr. Cox*

English 500. Topics in English and American Literary History.

Graduate research and thesis for the degree of Master of Arts. *Staff*

English 505a. Chaucer 3-0-3).

A study of the complete poetical works and selected background materials. *Mr. Kelly*

English 505b. Middle English Literature (3-0-3).

An introduction to the Middle English lyric and drama; the Alliterative Revival; selections from 15-century authors. Special attention is given to allegory. *Mr. Kelly*

English 510a, b. Old English (3-0-3, each sem.).

Reading and critical study of *Beowulf* and other selected literary texts. *Mr. Cox*

English 515a, b. Seminar in Sixteenth-Century Literature (3-0-3, each sem.). *Miss Williams*

English 520a. Seminar in the Romantic Period: Wordsworth, Coleridge (3-0-3). *Mr. Grob*

English 520b. Seminar in the Romantic Period: Byron, Shelley, and Keats (3-0-3). *Mr. Dowden*

English 530a. Bibliography and Methodology (3-0-3).

The course is designed to acquaint students with the bibliographical guides and aids to literary research. Attention will also be given to methods of preparing papers, theses, and dissertations. *Mr. Thomas*

English 535a. Literary Criticism: History (3-0-3). *Mr. Dowden*

English 535b. Literary Criticism: Theory (3-0-3). *Mr. Spears*

English 545a. Victorian Literature (3-0-3). *Mr. Grob*

English 545b. Victorian Literature (3-0-3). *Mr. Grob*

English 550a, b. Shakespeare Seminar (3-0-3, each sem). *Mr. Camden*

English 555a, b. Seminar in Elizabethan and Jacobean Drama each sem.). *Mr. Camden*

English 560a, b. Eighteenth-Century Prose and Poetry (3-0-3, each sem.). *Mr. Battestin and Mr. McKillop*

English 565a, b. The Eighteenth-Century Novel (3-0-3, each sem.). *Mr. Battestin*

English 566a, b. The Nineteenth-Century Novel (3-0-3, each sem.). *Staff*

English 570a. Seminar in Seventeenth-Century Literature (3-0-3). *Mr. Baker and Mr. Parish*

English 570b. Milton Seminar (3-0-3). *Mr. Baker and Mr. Parish*

English 573b. The Restoration (3-0-3).

Dryden and the development of English neo-classicism (1660-1700), with readings in the historical, philosophical, and critical backgrounds of the period. *Mr. Battestin*

English 575a, b. Seminar in Nineteenth-Century American Literature (3-0-3, each sem.). *Mr. Ward*

English 580a, b. Directed Reading in English and American Literature (3-0-3, each sem.). *Staff*

English 585a, b. Modern British Poetry (3-0-3, each sem.). *Mr. Spears*

English 587a, b. Seminar in Modern American Literature (3-0-3, each sem.). *Mr. Isle*

English 600. Topics in English and American Literary History.

Graduate research and thesis for the degree of Doctor of Philosophy. *Staff*

English 700. Summer Graduate Research.

Open only to graduate students already admitted to study for an advanced degree. At least forty hours of library study and research per week. *Staff*

Fine Arts

Professors Chillman and O'Neil, *Chairman*
Associate Professor Parsons
Visiting Associate Professor Camblin
Visiting Assistant Professor Bang
Instructor Staley
Lecturers Badner, Brown, Havens, and Warren
Visiting Lecturer Alhadeff

Requirements for a Major in Fine Arts: Students are required to take at least six semester-courses in the history of art; eight are recommended. In addition, two semesters of art studio courses at the 300 or 400 level are a requirement; two semesters each of courses in either art studio or history of art are recommended.

ART STUDIO COURSES

Art 201a, 202b. Design (2-6-3, each sem.).

The fundamentals of visual design; point, line, plane, value, color, shape, form, texture, and light. Open to all students. *Mr. Camblin*

Art 225a, 226b. Drawing I (3-6-3, each sem.).

An introduction to the problems of drawing, using various media: pencil, charcoal, pen-and-ink, brush-and-ink. Open to all students.
Messrs. Parsons, Staley and Camblin

Art 325a, 326b. Drawing II (3-6-3, each sem.).

Continued study of drawing, with additional work in wash and other water media. Open to all students. *Mr. Staley*

Art 411a, 412b. Graphic Arts (1-6-3, each sem.).

Etching, lithography and other printmaking methods; both in black-and-white and in color. Prerequisite: Art 325. *Mr. Staley*

Art 425a, 426b. Painting (1-6-3, each sem.).

Problems of painting, both traditional and experimental, in various opaque media. Open to all students. *Mr. O'Neil*

Art 435a, 436b. Sculpture (1-6-3, each sem.).

Sculpture in clay, ceramics, metal, direct metal welding, and other sculptural media. Open to all students. *Mr. Parsons*

Art 450a, 451b. Special Problems (1-6-3, each sem.).

Advanced problems in painting or sculpture or printmaking with individual instruction and criticism. Prerequisite: one year of course in the area in which advanced work will be done. *Messrs. O'Neil, Parsons, Staley and Camblin*

HISTORY OF ART COURSES

History of Art 205a, 206b. Introduction to the History of Art (3-0-3, each sem.).

A survey of painting, sculpture, and architecture from the Paleolithic period to the twentieth century. Open to all students. *Mrs. Brown*

History of Art 215a, 216b. Ancient Art (3-0-3, each sem.).

Egypt, the Middle East, Greece, and Rome. Prerequisite: History of Art 205a, 206b, or permission of instructor. *Mr. Chillman*

History of Art 317a, 318b. Early Medieval, Byzantine, and Romanesque Art (3-0-3).

A survey of European architecture, sculpture and painting from the fourth to the twelfth century. Offered in alternate years; to be given in 1969-70. *Mrs. Brown*

History of Art 319a, 320b. Gothic Art (3-0-3).

A survey of European architecture, sculpture and painting, both religious and secular, from the mid-twelfth century to the early sixteenth century. Offered in alternate years; to be given in 1968-69. *Mrs. Brown*

History of Art 345a, 346b. Modern Architecture (3-0-3, each sem.).

Traces the evolution of modern architecture from the period of Romantic Classicism to the present. Particular emphasis upon developments after 1850, especially in America. Prerequisite: History of Art 205a, 206b, or permission of instructor. *Miss Caldwell*

History of Art 355a. The Arts of Early America (3-0-3).

A survey of the American Arts of the English colonies, from the 17th to the 19th centuries, with particular emphasis on the decorative arts. Illustrative material from the Bayou Bend Collection will be utilized. *Mr. Warren*

History of Art 415a, 416b. Renaissance and Baroque Art (3-0-3, each sem.).

The artistic expression of new perspectives and energies. Fall semester: Renaissance Art. Spring semester: Baroque and Rococo Art. Prerequisite: History of Art 205a, 206b, or permission of instructor. *Mrs. Brown*

History of Art 450a, 451b. Key Monuments (3-0-3, each sem.).

Masterpieces of architecture, sculpture, and painting. Examples are the Acropolis at Athens and the cathedral at Chartres. Lectures, discussion, and papers. Not primarily for Fine Arts majors, but open to Juniors, Seniors, and graduate students in other areas. *Mr. Chillman*

History of Art 460a, 461b. The Nineteenth Century (3-0-3, each sem.).

Survey of art in Europe and America from the late eighteenth century through Impressionism. Prerequisite: History of Art 205a, 206b, or permission of instructor. *Miss Caldwell*

History of Art 475a, 476b. Twentieth-Century Painting and Sculpture (3-0-3, each sem.).

Selective survey and discussion of principal phases of modern expression in Europe and America, from Post-Impressionism to the present. Prerequisite: History of Art 205a, 206b, or permission of instructor. *Miss Caldwell*

History of Art 491-5. Special Topics (3-0-3).

Independent study or seminars concerned with various aspects of the history of art. May be repeated for credit with a change of topic. Prerequisite: permission of instructor. *Staff*

THEATER COURSE

Theater 300a, 301b. Introduction to Theater (3-0-3, each sem.).

A study of the form and structure of drama from Greek to modern. Special emphasis on the analysis of plays from the viewpoints of the various theater artists: director, actor, and designer. *Mr. Havens*

French

Professors Bourgeois, Topazio, and Wadsworth, *Acting Chairman*
Visiting Professor Landré
Associate Professors Hodges, Lecuyer, Raaphorst, and Shelton
Assistant Professors Carrington, Curtis, and Tappan

Undergraduates may major in French, and there is a graduate program in French leading to the degrees of Master of arts and Doctor of Philosophy. A fully equipped language laboratory is in operation, and laboratory work is an important part of the elementary courses in French.

Undergraduate Majors. Students who intend to major in French should consult the section of this catalogue dealing with curricula and degrees to familiarize themselves with the University requirements; they should also consult with one of the senior members of the department. At least eight of the courses offered in fulfillment of major requirements must be numbered 300 or higher; ten are recommended. Qualified upperclassmen are offered an opportunity to engage in independent work. All departmental majors and prospective majors must have their programs appoved by a representative of the department.

Graduate Programs. Admission to graduate study in French will be granted to a limited number of qualified students. Evidence of qualification is a solid and distinguished undergraduate record in the study of French literature, and a capacity for independent work is also considered essential. The award of advanced degrees is not based solely on accumulation of credits or compliance with formal requirements. Candidates are expected to attain a wide general knowledge of the appropriate history and literature and to demonstrate their command of the French language. In most cases two years will be required for the completion of work for the degree of Master of Arts.

Requirements for the Degree of Master of Arts in French.

(a) Completion with high standing of a program approved by the department; normally this will include 18 semester hours in advanced courses plus thesis work.
(b) Passing a reading examination in one language other than French approved by the department.
(c) Passing a preliminary oral examination in French on the French authors indicated in a reading list provided.
(d) Completion of an acceptable thesis.
(e) Passing a final oral examination.

Requirements for the Degree of Doctor of Philosophy in French.

(a) Completion with high standing of a program approved by the

department; normally this will include 48 hours of credit, including those required for the degree of Master of Arts.

(b) Passing a reading examination in two languages other than that of the candidate's specialization and approved by the department.

(c) Passing a preliminary written and oral examination on the authors indicated in a reading list provided, and on the literature, culture, and civilization of France. The oral examination may be taken only after the successful completion of the preliminary written examination. Knowledge of a second literature is required, and appropriate reading lists will be available. NOTE: Requirements (b) and (c) must be met at least a year before the submission of a dissertation.

(d) Completion of a dissertation approved by the department: the dissertation is expected to represent an original contribution to knowledge.

(e) Passing a final oral examination on the dissertation and related fields.

Note: Regardless of the type of appointment held by the graduate student, he or she may be required to undertake research or teaching assignments, depending upon the background of the graduate student and the needs of the Department.

COURSES

French 101a, 102b. Elementary French (3-2-4, each sem.).

A close study of the fundamentals of French grammar and pronunciation. Exercises in written French. Oral practice, dictations, and translation of suitable texts. Language laboratory work required. *Mr. Tappan and Staff*

French 110. French for Graduate Students (3-0-0).

A rapid study of French grammar with special emphasis on syntactical difficulties encountered in the comprehension of the written language. (Noncredit course restricted to graduate students preparing for the graduate language examination.) *Mr. Hodges*

French 201a, 202b. Intermediate French (3-0-3, each sem.).

Emphasis on intensified oral, written, and translation practice. An introduction to some main currents in French literature. Readings of significant texts, composition, dictation, and conversation. *Mrs. Raaphorst and Staff*

French 301a, 302b. French Civilization and Advanced Composition (3-0-3, each sem.).

A thorough study of French manners as reflected in literature and in the arts. Phonetics. Oral and written reports in French. *Mr. Shelton and Staff*

French 311a. Survey of French Literature (3-0-3).

A comprehensive survey of the main currents in French literature from its beginning to the 19th century. Required for French majors. Recommended as background for higher numbered courses in French literature. *Mrs. Raaphorst and Staff*

French 312b. Survey of French Literature (3-0-3).

A comprehensive survey of the main current in French literature from the 19th

century to the present. Required for French majors. Recommended as background for higher numbered courses in French literature. *Mrs. Raaphorst and Staff*

French 318. The Renaissance (3-0-3).

A careful examination of the main intellectual and esthetic currents of the French renaissance with particular attention to Rabelais' *Gargantua* and *Pantagruel* and Montaigne's *Essais*. To be given in 1969-70. *Mr. Carrington*

French 321a. The Seventeenth Century (3-0-3).

French poets, novelists, and moralists of the early seventeenth century, notably Malherbe, Corneille, Descartes, and Pascal. *Mr. Wadsworth*

French 322b. The Seventeenth Century (3-0-3).

French writers of the classical period, notably Molière, La Fontaine, La Rochefoucauld, Racine, Boileau, La Bruyère, and Mme. de La Fayette. *Mr. Tappan*

French 331. The Eighteenth Century (3-0-3).

Montesquieu, Voltaire, Diderot, Rousseau, Baumarchais; also other selected authors. *Mrs. Raaphorst*

French 351a. French Romantic Poetry and Novel (3-0-3).

This course traces the development of the romantic movement through the novels of Chateubriand, Mme. de Stael, Constant, and George Sand, and the poetic works by Lamartine, Hugo, Vigny, and Musset. Class analysis of texts and essays in French. To be given in 1969-70. *Mr. Bourgeois*

French 352a. The Romantic Drama (3-0-3).

A survey of the historical novel in France, followed by a thorough study of plays written by Mérimée, Dumas, Père, Hugo, Vigny, and Musset. Analysis of texts and essays in French. To be given in 1968-69. *Mr. Bourgeois*

French 391. French Stylistics (3-0-3).

A study of present-day French in the context of general linguistics. Some work in the laboratory may be required. To be given in 1969-70. *Mr. Lecuyer*

French 392. French Phonetics and Diction (3-0-3).

Practical application of the study of phonetics to the methods of learning and teaching French. Some work in the laboratory may be required. *Mr. Lecuyer*

French 404. Directed Study and Senior Thesis (0-0-6).

Open only to Senior students selected after application to the department. An extensive program of research is undertaken, after consultation, with approval of the department. A paper embodying the results of the research must be submitted. At least four advanced courses in French are prerequisites.

French 411a. Introduction to Old French (3-0-3).

Rapid presentation of the phonology and syntax of Old French. Selected readings from the principal literary genres of the medieval period. *Mr. Tappan*

French 451a. French Realism and Naturalism (3-0-3).

A thorough study of major novels by Stendhal and Balzac. Discussions and essays in French. *Mr. Bourgeois*

French 452b. French Realism and Naturalism (3-0-3).

A study of significant novels by Flaubert, Maupassant, Zola, Daudet, and the de Goncourt brothers. Discussions and essays in French. *Mr. Bourgeois*

French 481b. Modern French Drama (3-0-3).

A study of significant plays of Giraudoux, Cocteau, Anouilh, Montherlant, Camus, and Sartre. Detailed study, discussion, and written analyses in French. *Mr. Landré*

French 482a. Modern French Novel (3-0-3).

A study of major novels of Proust, Gide, Mauriac, Saint-Exupéry, Camus, and others. Detailed study, discussion, and written analyses in French. *Mrs. Raaphorst*

French 491. Special Topics (3-0-3).

Qualified students may, on the recommendation of the Department, undertake a special research assignment. May be repeated for credit with the assignment of an additional topic. *Staff*

French 500. Graduate Research.

Graduate research and thesis in partial fulfillment of the requirements for the degree of Master of Arts.

French 512b. Topics in Medieval Literature (3-0-3).

An intensive study of one genre, author, or work of the medieval period. Prerequisite: French 411a. To be given in 1969-70. *Mr. Tappan*

French 517a. Seminar in Renaissance Literature (3-0-3).

The topic will change from year to year; may be repeated for credit. The topic for 1968-69 will be the poetry of Marot and the Ecole de Lyon. *Mr. Carrington*

French 518b. Seminar in Renaissance Literature (3-0-3).

The topic will change from year to year; may be repeated for credit. The topic for 1968-69 will be Montaigne. *Mr. Wadsworth*

French 526a. Seminar in Classical Prose and Poetry (3-0-3).

The topic will change from year to year; may be repeated for credit. The topic for 1968-69 will be La Fontaine and Boileau. *Mr. Wadsworth*

French 527b. Seminar on Classical Drama (3-0-3).

The topic will change from year to year; may be repeated for credit. The topic for 1968-69 will be Racine. *Mr. Tappan*

French 535a. Seminar in Eighteenth-Century Literature (3-0-3).

The topic will change from year to year; may be repeated for credit. The topic for 1968-69 will be Montesquieu and Diderot. *Mr. Topazio*

French 536b. Seminar in Eighteenth-Century Literature (3-0-3).

The topic will change from year to year; may be repeated for credit. The topic for 1968-69 will be the eighteenth-century novel. *Mr. Topazio*

French 555a. Seminar in Romanticism (3-0-3).

The topic will change from year to year; may be repeated for credit. The topic for 1968-69 will be Vigny. *Mr. Bourgeois*

French 556b. Seminar on Victor Hugo (3-0-3).

The poet, novelist, and leader of the Romantic School, to 1840. *Mr. Landré*

French 568b. Seminar in Realism and Naturalism (3-0-3).

The topic will change from year to year; may be repeated for credit. The topic for 1968-69 will be Stendhal. *Mr. Bourgeois*

French 571a. Seminar in Modern Literature, to 1950 (3-0-3).

The topic will change from year to year; may be repeated for credit. The topic for 1968-69 will be Proust. *Mrs. Raaphorst*

French 572b. Seminar in Modern Literature, to 1950 (3-0-3).

The topic will change from year to year; may be repeated for credit. The topic for 1968-69 to be announced. *Mr. Landré*

French 577a. Seminar in Contemporary Literature (3-0-3).

The topic will change from year to year; may be repeated for credit. Not offered in 1968-69. *Mr. Lecuyer*

French 578b. Seminar in Contemporary Literature (3-0-3).

The topic will change from year to year; may be repeated for credit. Not offered in 1968-69. *Mr. Lecuyer*

French 579. Studies in French Poetry (3-0-3).

Problems of versification, imagery, and literary analysis. *Mr. Wadsworth*

French 592. French and English Stylistics (3-0-3).

A study of the characteristics of the French and English languages and of their differences with application to the problems of composition and translation. *Mr. Lecuyer*

French 595. Special Topics in French Literature (3-0-3).

This course is designed to fill particular lacunae in a doctoral candidate's program. Subjects would therefore change according to specific needs of students. Can be repeated for credit since topics would change. *Staff*

French 600. Graduate Research.

Graduate research and dissertation in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Geology

Professors Adams, *Chairman*,
Croneis, De Bremaecker, Rogers, and J. L. Wilson
Associate Professors D. R. Baker, Burchfiel, Heymann, and Lankford
Assistant Professors Clark and Warme
Visiting Lecturer Nettleton

In January, 1952, Mrs. Olga Wiess provided an endowment fund to establish the Harry Carothers Wiess Chair of Geology as a memorial to her husband. As a result, the Department of Geology was created, and a full program of courses in the subject is being offered. The first Senior class in geology was graduated in June, 1955, and the first doctorate was awarded in June, 1958. A geology laboratory, completed in June, 1958, provides ample space and facilities for undergraduate and graduate instruction and research.

Until June, 1964, all geology majors were in the science-engineering program; beginning in the 1964-65 academic year, however, it has been possible for students to major in geology in either the science-engineering or the academic programs.

Undergraduate Requirements. In addition to the satisfaction of the general requirements of the science-engineering or academic programs, undergraduate majors in geology are expected to complete the following courses:

Geology 200a, 201b ordinarily taken in the Sophomore year, but may be delayed to the Junior year.

Geology 310a, 330a, 310b, 331b taken in the Junior year.

Geology 400a, 401b taken in the Senior year
One to two year-courses (two to four semester-courses) of approved geology electives
Geology 390 or other approved summer field course; ordinarily taken in the summer between the Junior and Senior years.

An honors program open to undergraduate majors was initiated in the spring of 1967. In addition to the required six-week summer field course, honors students will be involved in an extended field problem for the remainder of the summer preceeding their Senior year, the results to be submitted as a Senior Honors Thesis.

Graduate Requirements. Students with a bachelor's degree in geology or related sciences from Rice University, or an equivalent degree from another institution of similar standing, are considered for admission to graduate work.

Graduate work is conducted in those specialties that are compatible with the equipment available and with the interests of the staff. At present, the Department of Geology is prepared to offer advanced work in geochemistry, geophysics, igneous and metamorphic petrology, marine geology, meteoritics, stratigraphy, sedimentation, sedimentary petrology, structural geology, and paleontology, micropaleontology, and paleoecology. Graduate work in geology is oriented toward the theoretical and fundamental aspects of the subject rather than directly toward its many applied aspects.

Candidates for advanced degrees in geology will be expected to:

(1) Pass a reading examination in one foreign language for the master's degree; German is ordinarily required, but the Geology Department may permit the substitution of French in some cases. Candidates for the Ph.D. degree must pass reading examinations in two languages, one of which must be German.
(2) Complete at a high level an approved program of graduate courses in geology and related subjects. This program may include an advanced field course and undergraduate courses in certain supporting sciences, such as mathematics (calculus), chemistry, physics, and biology. Prospective students with deficiencies in such supporting sciences will find their graduate program greatly accelerated by removing those deficiencies prior to enrolling for graduate work.
(3) Pass a set of basic examinations in geology. These examinations are ordinarily given early in a student's graduate career and may at the discretion of the department, be repeated one or more times in whole or in part. Ph.D. candidates are expected to achieve higher scores than master's candidates. In some cases, specific examinations may be waived in lieu of high grades in related courses.
(4) Complete for publication a thesis which represents an original contribution to the science.

(5) Pass an oral examination covering the candidate's research work and related phases of geology.
(6) Engage in some laboratory instruction regardless of the type of appointment. This experience is considered an important and valuable part of graduate training, and every effort is made to give as great a variety of assignments as possible.

Most graduate students can expect to spend two years beyond the bachelor's degree in order to complete requirements for the master's degree and an additional two years for the Ph.D. degree. Some students of very high ability may be allowed to bypass the master's degree and work directly for the Ph.D.

COURSES

Geology 200a. Physical Geology (3-3-4).

An introduction to the study of the physical, chemical, and geological processes that produce rocks, economic deposits, and landforms. The laboratory includes exercises with advanced instrumentation, map and structure interpretation, and the identification of hand specimens of rocks and minerals. Prospective majors in geology are expected to have had Chemistry 120a,b, Physics 100a,b, and Mathematics 100a,b. Laboratory fee required. *Messrs. Adams and Rogers*

Geology 201b. Historical Geology (3-3-4).

An introduction to the study of the physical events of the ancient past from the birth of the earth through the most recent ice age, together with a synopsis of the concurrent changing patterns of life. The laboratory includes the analysis of geological maps with emphasis on the structure of the stratified rocks and their organic remains. Prerequisite: Geology 200a or consent of the department. Laboratory fee required. *Mr. Lankford*

Geology 310a. Mineralogy (3-4-4).

Basic introduction to crystallography, crystal chemistry, systematics and classification, physical and chemical properties, distribution, occurrence, and genesis of minerals. Laboratory work stresses modern techniques and procedures of determinative mineralogy including optical mineralogic methods utilizing the polarizing microscope. The common rock-forming minerals receive principal emphasis. Laboratory fee required. *Mr. Baker*

Geology 310b. Petrology (3-6-5).

Description and interpretation of igneous, metamorphic, and sedimentary rocks. Laboratory work emphasizes the study of rock thin sections with the petrographic microscope. *Mr. Rogers*

Geology 320a. Environmental Geology (3-0-3).

A study of the early inorganic evolution of terrestrial conditions favorable for life, the mechanisms by which life adjusted to these conditions and the ways in which man's activities, including pollution, are changing these conditions and the mechanisms of adjustment. *Mr. Adams*

Geology 321b. Mineral Resources (3-0-3).

An introduction to the study of the geology, origin, and general economics of mineral and fuel deposits. Topics for study include the analysis of significant occurrences and methods of exploration. Prerequisite: Consent of the department. *Mr. Adams*

Geology 330a. Structural Geology (3-4-4).

Introduction to structural geology and field methods. Topics covered include de-

scription of faults, folds, and other structural features, field methods for recognizing and interpreting structures, mechanics of rock deformation, and elementary tectonics. Laboratory work involves descriptive geometry, plane table surveying, aerial photograph interpretation, and preparation of geologic maps. Laboratory fee required.
Mr. Bruchfiel

Geology 331b. Sedimentation (3-3-4).

Introduction to the study of sedimentary rocks. Emphasis is placed on the processes of weathering, transportation, and deposition and on the petrographic attributes of the more important types of sedimentary rocks. Laboratory work is concerned largely with sedimentation analyses and the description of hand specimens and thin sections. Prerequisite: Geology 310a. Laboratory fee required. *Mr. Lankford*

Geology 390. Field Geology.

In addition to the various shorter field trips conducted in connection with a number of the geology courses taken in residence, a summer field course of not less than six weeks is required of all majors. The work may be taken at any one of several approved university field stations during the summer prior to the Senior year. Credit variable. Laboratory fee required.

Geology 400a. Invertebrate Paleontology (3-4-4).

An introduction to the morphology and geological record of the major invertebrate groups characterized by significant fossil representation. Brief consideration of principles of evolution, paleoecology, correlation, and stratigraphic nomenclature. Laboratory fee required. *Messrs. Warme and Wilson*

Geology 401b. Stratigraphy and Advanced Historical Geology (3-4-4).

Principles of stratigraphy and correlation problems. Stratigraphic and paleotectonic development of North America and Europe. Use and interpretation of thickness and facies maps and cross sections. Laboratory consists of suites of fossils and rock types characteristic of various geologic periods. Prerequisite: course in paleontology and sedimentation or approval of department. Laboratory fee required.
Mr. Wilson

Geology 405a. Micropaleontology (2-6-4).

A microscopic study of the plant and animal remains commonly recoverable from drill cuttings. Principles underlying the use of such fossils in local and worldwide correlations. Prerequisite: Geology 401b or consent of the department. Laboratory fee required. *Mr. Lankford*

Geology 411b. Igneous and Metamorphic Petrology (3-4-4).

Development of the basic principles of igneous and metamorphic petrology. Emphasis is placed on the application of physical chemistry and experimental petrology for the elucidation of classical field and petrographic relationships. The origin and evolution of major petrologic types is discussed. Laboratory work involves petrographic study of selected suites of important rocks. Prerequisite: Geology 310a,b. Laboratory fee required. *Mr. Baker*

Geology 418a. Marine Geology (3-3-4).

A study of the major components of modern ocean basins and margins including their sediments, sedimentary environments, marine processes, and interpretations of bathymetry, structure, and history. The course will include field trips along the Gulf Coast and in the Gulf of Mexico. Prerequisites: Geology 330a and 331b. Laboratory fee required. *Mr. Lankford*

Geology 440a. Introduction to Geophysics (3-4-4).

A consideration of the gravitational, magnetic, thermal, electromagnetic, and seismic properties of the solid earth. Potential theory is introduced. Geophysical observations of the earth's crust and interior are interpreted in terms of physical principles. Laboratory fee is required. *Mr. Clark*

Geology 455a, b. Geochemistry (3-4-4, each sem.).

A study of the geological and chemical processes that produced the observed

distribution and abundances of the elements. The age, formation, and heat balance of the earth are some of the topics discussed from a geochemical viewpoint. Laboratory work includes both wet chemical and modern instrumental determinations of major and trace elements in rocks and minerals. Prerequisite: Geology 310a and consent of the department. Laboratory fee required. *Mr. Adams*

Geology 480. Research in Geology.

Advanced work adapted to the needs of the individual student. Credit variable. Laboratory fee required.

Geology 490. Recent Advances in Geology.

A study of recent research in specific fields under the guidance of a member of the staff. Credit variable. Laboratory fee required.

Geology 500. Special Studies.

Advanced work in certain phases of geology, adapted to the needs of individual graduate students. Registration permitted only with consent of the department. Credit variable.

Geology 510-518. Seminars in Geology.

Courses covering the subjects listed in sequence under geology research courses numbered 590 to 598. Individual seminars may cover different topics in different years and may be taken more than once. All seminars three units per semester. *Staff*

Geology 520a, b. Geophysics (3-4-4, each sem.).

Gravity, magnetism, paleomagnetism, potential theory, heat flow, elasticity, and elastic waves theory. Emphasis is on the principles and the mathematical physics. Laboratory work is concerned with applications of the methods. Prerequisite: consent of the department. Laboratory fee required. *Messrs. De Bremaecker and Clark*

Geology 525b. Organic Geochemistry (3-0-3).

A study of the application of the principles and procedures of organic chemistry to geologic problems. The nature and classification of naturally occurring carbonaceous substances is reviewed. Emphasis is given to major problems of organic geochemistry such as the evolution of petroleum and other fossil fuels; the nature, distribution, and origin of organic substances in sediments and sedimentary rocks; the geochemical cycle of carbon; the recognition of biochemical substances in ancient rocks and meteorites; and the use of organic constituents for deciphering the physical, chemical, and biological history of rocks. *Mr. Baker*

Geology 530a. Advanced Sedimentary Petrology (3-4-4).

A survey of sedimentary processes (weathering, transportation, deposition, and diagenesis) and sedimentary rocks. Selected topics will be studied in the fields of sedimentary mineralogy, lithofacies analysis and environmental interpretation, and tectonic sedimentation. Laboratory work includes sedimentation analysis and thin section study of sedimentary rocks. *Messrs. Lankford, Baker, and Wilson*

Geology 531b. Advanced Topics in Petrology (3-0-3).

A study of major problems of igneous and metamorphic petrology. Topics include origin of magmas, the granite problem, basalts, and volatiles in silicate systems. Topics will vary from year to year. *Mr. Rogers*

Geology 540b. Statistical Geology (3-3-4).

Fundamentals of statistical analysis and their application to geologic problems. Topics covered include sampling distributions, comparison of means and variances, correlation and regression, chi-square analysis, variance analysis, and handling of multiple sets of data. *Mr. Rogers*

Geology 550a, b. Chemical Geology (3-3-4, each sem.).

Survey of physical chemistry and its applications to geologic studies. Topics covered include basic thermodynamics, phase equilibria and solution chemistry, reaction kinetics, crystal chemistry, and crystal growth. *Mr. Heymann*

Geology 555a. Advanced Topics in Geochemistry (3-3-4).

A study of selected topics, particularly radiometry, isotope and trace element analysis and interpretation. *Mr. Adams*

Geology 555b. Radiogeology (3-4-4).

The detection and quantitative determination of natural and artificial radioactive nuclides with particular emphasis on the geologic mechanisms of mobilization, transportation, and fixation in the lithosphere, hydrosphere, atmosphere, and biota. Alpha, beta, and gamma detection in the field and laboratory, as well as alpha and gamma pulse-height analysis in the laboratory, are considered in both theory and practice. Gamma spectrometry in the field is also included. The biological and health aspects of the radiation environment are discussed.

Mr. Adams and others

Geology 560a, b. Advanced Topics in Geophysics (3-3-4, each sem.).

Study of selected topics in geophysics, including seismology, gravitation, and geomagnetism. *Messrs. De Bremaecker and Clark*

Geology 566a, b. Advanced Tectonics (3-3-4, each sem.).

Mechanics of rock deformation and its relation to field observations and an understanding of faulting, folding, and minor structures. Study of selected structural problems and regional tectonics. *Mr. Burchfiel*

Geology 582b. Meteoritics (3-0-3).

A study of the composition, structure, ages, and origin of meteorites with special emphasis on the implications for the history of the solar system. The course will include a discussion of experimental methods in cosmochemistry. *Mr. Heymann*

Geology 590. Research in Physical and Structural Geology (0-9-3).

Messrs. Burchfiel and De Bremaecker

Geology 591. Research in Mineralogy (0-9-3).

Staff

Geology 592. Research in Petrography and Petrology and in Carbonate Geology (0-9-3).

Messrs. Rogers and Wilson

Geology 593. Research in Geochemistry and Meteoritics (0-9-3).

Messrs. Adams, Baker, and Heymann

Geology 594. Research in Geophysics (0-9-3).

Messrs. De Bremaecker and Clark

Geology 595. Research in Invertebrate Paleontology and Stratigraphy (0-9-3).

Messrs. Croneis, Lankford, Warme and Wilson

Geology 596. Research in Economic and Petroleum Geology (0-9-3).

Staff

Geology 597. Research in Regional Geology (0-9-3).

Staff

Geology 598. Research in Marine Geology (0-9-3).

Mr. Lankford

Germanics

Professor Kahn, *Chairman*
Visiting Professor Malsch
Associate Professors Koepke and Wilson
Assistant Professors Copeland, Goodwin, Milburn, Puppe, Schubert, Stavenhagen and Winkler
Instructors Christiansen, Klein, Slayton, Van Houten

Requirements for an Undergraduate Major in German.

(a) Completion of a program approved by the department.
(b) The equivalent of at least eight semester-courses in German numbered 300 or higher.
(c) It is recommended that German majors take collateral courses in other literatures, history, and philosophy.

Requirements for the Degree of Master of Arts in German.

(a) Completion with high standing of a program approved by the department; normally this will include eight graduate semester-courses.
(b) Passing a reading examination in one foreign language other than German approved by the department.
(c) Completion of an acceptable thesis.
(d) Passing an oral examination based in part on a reading list provided by the department.
(e) Passing a final oral examination on the thesis.

Requirements for the Degree of Doctor of Philosophy in German.

(a) Completion with high standing of a program approved by the department; normally this will include sixteen graduate semester-courses, including those required for the degree of Master of Arts.
(b) Passing a reading examination in two foreign languages other than German approved by the department.
(c) Passing a preliminary written and oral examination on the general field of Germanic studies: this examination will be based in part on a reading list provided by the department.
Note: Requirements (b) and (c) must be met at least a year before the submission of a dissertation.
(d) Completion of a dissertation approved by the department; the dissertation is expected to represent an original contribution to knowledge.
(e) Passing a final oral examination on the dissertation and related fields.

As part of their training graduate students, regardless of the type

of appointment, will be required to perform some duties, such as assisting in classes, the language laboratory, research, and other activities suggested by the department.

COURSES

German 101a, 102b. Elementary German (4-1-4, each sem.).

Grammar, conversation, and extensive reading. Language laboratory work required. *Staff*

German 111a, 112b. German for Graduate Students (3-0-0, each sem.).

A noncredit course in German, restricted to graduate students preparing for the graduate language examination. The course stresses grammar. *Staff*

German 201a. Intermediate German (3-1-3).

Grammar, conversation, and extensive reading. Language laboratory work required. *Staff*

German 202b. Intermediate German: Scientific (3-0-3).

The course emphasizes readings in scientific German. Prerequisite: 201a. *Staff*

German 204b. Intermediate German (3-0-3).

The course stresses readings in literature. Prerequisite: 201a. *Staff*

German 301a. Advanced Scientific German (3-0-3).

German composition and conversation based on scientific texts. *Mr. Wilson*

German 302b. Advanced Scientific German (3-0-3).

The continuation of the above. Prerequisite: 301a or permission. *Mr. Wilson*

German 305a. Composition and Conversation (3-0-3).

The work will be based on literary texts. *Staff*

German 306b. Composition and Conversation (3-0-3).

The continuation of the above. Prerequisite: 305a. *Staff*

German 311a. Storm and Stress (3-0-3).

The course deals with the theories and literature of Preromanticism. Offered in alternate years: given in 1968-69. *Mr. Kahn*

German 312b. Schiller (3-0-3).

Offered in alternate years: given in 1968-69. *Mr. Kahn*

German 321a. Nineteenth-Century Dramatists (3-0-3).

The course emphasizes the works of Grillparzer, Büchner, and Hebbel. Offered in alternate years: given in 1968-69. *Mr. Milburn*

German 322b. Twentieth-Century Dramatists (3-0-3).

The course emphasizes the works of Wedekind, Brecht, and Dürrenmatt. Offered in alternate years: given in 1968-69. *Mr. Milburn*

German 331a. Survey of German Literature (3-0-3).

From the beginnings until the eighteenth century. Offered in alternate years: given in 1969-70. *Mr. Winkler*

German 332b. Survey of German Literature (3-0-3).

From the eighteenth century to the present. Offered in alternate years: given in 1969-70. *Mr. Winkler*

German 341a. Romanticism (3-0-3).

Offered in alternate years: given in 1968-69. *Mr. Lehnert*

German 342b. From Romanticism to Realism (3-0-3).

The course includes the study of Hölderlin, Heine, and Mörike. Offered in alternate years: given in 1968-69. *Mr. Lehnert*

German 351a. German Literature, 1850-1900 (3-0-3).

The course includes the study of Marx, Stifter, Keller, Wagner, and Nietzsche. Offered in alternate years: given in 1969-70. *Mr. Milburn*

German 352b. German Literature, 1850-1900 (3-0-3).

The course includes the study of Meyer, Nietzsche, Storm, Fontane, Freud, and naturalism. Offered in alternate years: given in 1969-70. *Mr. Milburn*

German 361a. Literature of the Enlightenment (3-0-3).

The course emphasizes Lessing and his time. Offered in alternate years: given in 1968-69. *Mr. Winkler*

German 362b. Literature of the Enlightenment (3-0-3).

The course emphasizes Klopstock and lyrical poetry. Offered in alternate years: given in 1968-69. *Mr. Winkler*

German 371a. Hofmannsthal (3-0-3).

Offered in alternate years: given in 1969-70. *Mr. Lehnert*

German 372b. Thomas Mann (3-0-3).

Offered in alternate years: given in 1969-70. *Mr. Puppe*

German 381a. German Literature since 1900 (3-0-3).

The course deals chiefly with the poetry of Rilke, George, and Benn. Offered in alternate years: given in 1968-69. *Mr. Puppe*

German 382b. German Literature since 1900 (3-0-3).

The course treats primarily the prose writings of Kafka, Broch, and Döblin. Offered in alternate years: given in 1968-69. *Mr. Puppe*

German 391a. Goethe: 1749-1788 (3-0-3).

Offered in alternate years: given in 1969-70. *Mr. Kahn*

German 392b. Goethe: 1788-1832 (3-0-3).

Offered in alternate years: given in 1969-70. *Mr. Kahn*

German 401a. Independent Work: Special Topics in German Literature or Philology (0-0-3).

Independent work for qualified students: may be repeated for credit. *Staff*

German 402b. Independent Work: Special Topics in German Literature or Philology (0-0-3).

The same as the above: may be repeated for credit. *Staff*

German 411a. German Literature of the Renaissance and Reformation (3-0-3).

Offered in alternate years: given in 1968-69. *Mr. Stavenhagen*

German 412b. German Literature of the Baroque (3-0-3).

Offered in alternate years: given in 1968-69. *Mr. Schubert*

German 500a, b. Graduate Research.

Graduate research and thesis in partial fulfillment of the requirements for the degree of Master of Arts.

German 501a. Seminar in the Literature of the Nineteenth and Twentieth Centuries (3-0-3).

The topics will change from year to year: may be repeated for credit. *Mr. Lehnert*

German 502b. Seminar in the Literature of the Nineteenth and Twentieth Centuries (3-0-3).

The topics will change from year to year: may be repeated for credit. The topic in 1968-69 will be problems in Franz Kafka. *Mr. Lehnert*

German 503a. Special Topics in Germanic Philology (3-0-3).

The topics will change from year to year: may be repeated for credit. The topic in 1968-69 will be Baroque lyric. *Mr. Schubert*

German 504b. Special Topics in Germanic Philology (3-0-3).

The topics will change from year to year: may be repeated for credit. The topic in 1968-69 will be history of the German language. *Mr. Copeland*

German 505a. Seminar in Enlightenment, Classicism, and Romanticism (3-0-3).

The topics will change from year to year: may be repeated for credit. The topic in 1968-69 will be Goethe, 1749-1788. *Mr. Kahn*

German 506b. Seminar in Enlightenment, Classicism, and Romanticism (3-0-3).

The topics will change from year to year: may be repeated for credit. The topic in 1968-69 will be Goethe, 1788-1832. *Mr. Kahn*

German 507a. Special Topics in German Literature (3-0-3).

The topics will change from year to year: may be repeated for credit. *Staff*

German 508b. Special Topics in German Literature (3-0-3).

The topics will change from year to year: may be repeated for credit. *Staff*

German 509a. Seminar in Bibliography, Research Problems, and Literary Theory (3-0-3).

The course treats problems in bibliography and literary research. *Mr. Schubert*

German 510b. Seminar in Bibliography, Research Problems, and Literary Theory (3-0-3).

The course treats chiefly problems of literary theory and criticism. *Mr. Winkler*

German 511a. Old Saxon (3-0-3).

Offered in alternate years: given in 1969-70. *Mr. Wilson*

German 512b. Old Icelandic (3-0-3).

Offered in alternate years: given in 1969-70. *Mr. Wilson*

German 521a. Gothic (3-0-3).

Offered in alternate years: given in 1968-69. *Mr. Wilson*

German 522b. Old High German (3-0-3).

Offered in alternate years: given in 1968-69. *Mr. Wilson*

German 531a. Middle High German (3-0-3).

An introduction to the study of Middle High German. The *Nibelungenlied* will be read. Offered in alternate years: given in 1969-70. *Mr. Stavenhagen*

German 532b. Middle High German (3-0-3).

Emphasis will be placed on the Middle High German lyric. Offered in alternate years: given in 1969-70. *Mr. Stavenhagen*

German 551a. Seminar in Modern Literature (3-0-3).

Literary problems of the early twentieth century. Offered in alternate years: given in 1969-70. *Mr. Puppe*

German 552b. Seminar in Modern Literature (3-0-3).

Literary problems of the twentieth century. Offered in alternate years: given in 1969-70. *Mr. Puppe*

German 600a, b. Graduate Research.

Graduate research and dissertation in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Greek

(*See* pages 137-138)

Health and Physical Education

PROFESSORS HERMANCE, BEARDEN, *Chairman,* AND POINDEXTER
ASSISTANT PROFESSORS BARKER, BLAND, RICHARDSON, AND SPENCE
LECTURERS CHARLTON AND GRIFFITHS

Basic Health and Physical Education (101a, 102b Women) (103a, 104b Men) (0-4-0).

A course to discuss the place and importance of health and physical education in our modern society, to teach the skills and knowledge of physical education activities, and to familiarize the students with the physical education facilities and equipment available to them at Rice University. Two-hour periods each week. Required of all freshmen. *Staff*

Health and Physical Education 100a. Foundations of Physical Education (3-0-3).

This course investigates the underlying factors that structure the physical education discipline. A study is made of the nature and scope of physical education, philosophy of physical education as part of general education, history of physical education, and the biological, psychological, and sociological interpretation of physical education. *Mr. Bearden*

Health and Physical Education 110b. Foundations of Health Education (3-0-3).

An introduction to the nature of growth and development of health education and anatomy. Emphasis is placed on the understanding of basic anatomy and physiology of the human body and its relationship and contributions to physical education, health education and education. *Miss Richardson*

Health and Physical Education 125a, 126b. Laboratory (0-3-2, each sem.).

The following physical education athletic activities are included in this course: handball, soccer, tumbling, swimming and diving. Satisfactory completion of the swimming unit leads to certification as a Red Cross Water Safety Instructor. For each activity a study is made of the history, educational values, activity skills and game formations, methods of teaching and coaching, court and field construction, officiating, and audiovisual aids. Laboratory fee required. *Mr. Bland*

Physical Science 110a, b. The Fundamentals of the Physical Sciences. (3-0-3, each sem.).

A study of the basic principles of chemistry, physics, geology, astronomy, and meteorology with special emphasis upon the impact of science and technology on society. *Mr. Hermance*

Health and Physical Education 200a. Principles and Philosophy of Physical Education in the United States (3-0-3).

A study of physical education, recreational sports, and athletics in education and society. Emphasis is placed upon the biological basis of life, the unity of mind and body, the structure and function of the human organism in relation to social values, human behavior, and physical efficiency, and physical education in an age of automation and leisure. A study will be made of the American Association for Health, Physical Education, and Recreation, the Olympic Games, the National Collegiate Athletic Association, the Amateur Athletic Union, interscholastic and intercollegiate conferences, Little Leagues, and the camping movement. *Mrs. Poindexter*

Health and Physical Education 210b. Intramural Sports, School-Community Recreation Programs, and Safety Education (3-0-3).

A study is made of the educational values of intramural sports and recreation including leadership, organization and administration, units of competition, scoring plans and tournaments, facilities and equipment, publicity, and public relations. Safety education includes a survey of the safety movement in business, industry, and education, the program of safety education, professional liability, and safety standards. *Mr. Barker*

Health and Physical Education 225a, 226b. Laboratory (0-3-2, each sem.).

The following physical education activities are included: archery, tennis, squash, volleyball, badminton, fencing, and apparatus. For each activity a study is made of the history, educational values, court and field construction, activity skills and game formations, methods of teaching and coaching, officiating, and audiovisual aids. Laboratory fee required. *Mr. Barker*

Health and Physical Education 300a. Kinesiology (3-0-3).

This course is an introduction to kinesiology and a review of skeletal and muscular anatomy. It includes an analysis of selected physical education activities and investigates physical principles of equilibrium, motion, and force underlying bodily movement. *Mr. Spence*

Health and Physical Education 310b. Methods, Materials, and Curriculum Construction in Physical Education and Interscholastic Athletics, Grades 7-12 (3-0-3).

This course of study includes a study of methods of teaching physical education, materials of the program, and curriculum construction in physical education and interscholastic athletics. Special emphasis is placed upon teaching techniques and the learning process, class management, testing and grading, units of instruction, audiovisual and material aids, and curriculum construction based upon sports and games, recreational and lead-up activities, aquatics, social and rhythmic activities, self-testing activities, and the fundamental skills of movement. *Mr. Hermance*

Health and Physical Education 320a. Tests and Measurements and Adaptive Physical Education (3-0-3).

This course includes anthropometric measurements, cardiac function tests, athletic achievement tests, classification tests, motor ability and capacity, motor fitness tests, and statistical methods. Adaptive physical education includes a study of society of the disabled and the retarded, adjustment problems of the handicapped, and the program of physical education for the handicapped. *Mr. Bearden*

Health and Physical Education 321b. Physiology of Muscular Activity (3-0-3).

This course investigates the specific effects of exercise upon the body systems with special emphasis on the circulatory, respiratory, and muscular systems. *Mr. Spence*

Health and Physical Education 325a, 326b. Laboratory (0-3-2, each sem.).

The following physical education, recreation, and athletic activities are included: golf, weight training, wrestling, basic rhythms, recreational and lead-up games, first aid and softball. A study of first aid leads to the standard certification in first aid by the American Red Cross. For each activity a study is made of the history, educational values, court and field construction, activity skills and game formations, methods of teaching and coaching, officiating, and audiovisual aids. Laboratory fee required. *Mr. Charlton*

Health and Physical Education 400a. Organization and Administration of Health and Physical Education (Including Interscholastic Athletics), Grades 7-12 (3-0-3).

This course is based upon a study of the organization and administration of programs of health, physical education, and interscholastic athletics, including administrative policies and procedures, staff, budget, facilities and equipment, office management, schedules, public relations, and publicity. *Mr. Hermance*

Health and Physical Education 410b. Methods, Materials, and Curriculum Construction in Health Education, Grades 7-12 (3-0-3).

This course is based upon a study of content and methods of teaching health education, materials of the program, and curriculum construction in school health education including student health service, school health environment, health instruction, resources for health education, appraisal of physical and mental health, the medical examination, school health council, audiovisual and material aids, and demonstrations. *Miss Richardson*

Health and Physical Education 425a, 426b. Laboratory (0-3-2, each sem.).

The following physical education and athletic activities are included: football, basketball, baseball, track and field, and the care and prevention of athletic injuries. For each activity a study is made of the history, educational values, court and field construction, activity skills and game formations, audiovisual aids, and the psychology and techniques of teaching and coaching interscholastic athletics. The care and prevention of athletic injuries includes a study of weight-control programs in athletics, drugs, massage, strains, sprains, contusions, dislocations, fractures, taping, impact force in athletics, basic conditioning, and training-room design, equipment, and operation. *Mr. Bland*

History

Professors Craig, Drew, Higginbotham, Hyman, Lear, Muir, Rath, and Vandiver, *Chairman*
Associate Professors Galambos, Garside, *Associate Chairman,* Gruber, Loewenheim, Matusow, and Nell
Assistant Professors Barker, Stokes, and Wiener

HISTORY

Undergraduate Majors. Undergraduates majoring in history are normally expected to take the equivalent of six year-courses in history approved by the department, including two of the following: History 100a,b, History 110a,b, and History 200a, 201b. With the permission of the department, advanced work in the history of art or in political science may be substituted for not more than two advanced semester-courses in history. French or German is recommended as the foreign language for history majors; other languages may be accepted when special circumstances justify their substitution.

Graduate Work in History. Graduate students in history are accepted for study leading to either the M.A. or Ph.D. degree. Holders of the B.A. degree (or its equivalent) from an acceptable institution are eligible to apply. Since the graduate program is designed to train a limited number of carefully selected students, emphasis is on quality rather than quantity. Both the M.A. and the Ph.D. degrees are offered in limited areas of American history and in several areas of medieval and modern European history, further information about which may be obtained on request from the department.

Graduate fellowships as well as graduate scholarships are awarded on application to qualified students of demonstrated ability. Graduate fellows are expected to render limited services to the department, although these services are not intended to be so heavy as to prevent the student's carrying a full study load. A number of graduate fellows are given the opportunity to gain experience in helping to edit either the *Journal of Southern History* or the *Austrian History Yearbook,* both of which are sponsored by Rice University. The department also recommends a number of graduate students for NDEA fellowships.

Requirements for the M.A. Candidates for the M.A. are expected to complete a certain amount of formal class or seminar work, usually the equivalent of eight semester-courses, in addition to passing a reading examination in one foreign language (usually French or German) and writing a thesis under the direction of an advisory committee of the department headed by a professor having special competence in the subject area of the thesis. An oral defense of the

thesis is also required. Completion of these requirements usually takes two years, although a special accelerated program is designed to award the M.A. after the completion of the work of one summer and one school year beyond the B.A. degree.

Requirements for the Ph.D. Candidates for the Ph.D. degree are expected to prepare themselves for a preliminary examination in two fields in their area of major concentration and in one minor field. Such preparation will normally include course work, seminars, directed reading, and a substantial amount of independent reading by the student. The comprehensive examination, which will include an oral and may include a written examination, is given only after the student has completed his course and seminar work and passed a reading examination in two foreign languages (usually French and German). In addition to the two foreign language examinations and the comprehensive examination, the Ph.D. candidate must present and defend a thesis embodying the results of original research.

COURSES

History 100a, b. Europe since 1500 (3-0-3, each sem.).

An examination of the development of European civilization since the Renaissance. *Mrs. Drew, Mr. Garside, and others*

History 110a, b. American History (3-0-3, each sem.).

A survey of the growth of the American nation, with considerable attention to its European background. Recommended as fulfilling the state requirement for prelegal and premedical students as well as for students seeking a teaching certificate. *Messrs. Matusow, Vandiver and others*

History 200a. Ancient History (3-0-3).

This course, together with History 201b, is intended to provide a historical background for the various humanistic branches of study. The work of the first semester is largely devoted to the history of the ancient Near East, Greece, and the Roman Republic. *Mrs. Drew*

History 201b. Medieval History (3-0-3).

This course is designed to be a continuation of History 200a. Its work is largely devoted to a study of the Roman Empire and the Middle Ages. *Mrs. Drew*

History 304a, b. Independent Reading (3-0-3, each sem.).

Independent reading under the supervision of a member of the department. Open to Juniors in the Honors Program and occasionally to others with special permission. *Staff*

History 315a. America since the Civil War I (3-0-3).

This is a discussion course dealing with the major intellectual, social, and political trends in the life of the American people since the Civil War. The first semester of the course begins with Reconstruction and ends with the Progressive Era. Open only to Juniors and Seniors with the consent of the instructor. *Mr. Matusow*

History 316b. America since the Civil War II (3-0-3).

A continuation of History 315a. This semester covers the period from World War I through the Johnson administration. Open only to Juniors and Seniors with the consent of the instructor. *Mr. Matusow*

History 320a, b. Trends in European Culture during Antiquity and the Middle Ages (3-0-3, each sem.).

This course traces selected aspects of European thought from Periclean Athens to the later Middle Ages, with special reference to Hellenistic and Greco-Roman influences. Religious, philosophical, and scientific implications are examined in some detail. Prerequisite: History 200a and 201b or consent of instructor. Also offered as Classics 320a,b. *Mr. Lear*

History 330a. The Renaissance, 1250-1527 (3-0-3).

A survey of European history from the end of the Hohenstaufen Empire to the sack of Rome in 1527, with primary emphasis on Italy. *Mr. Garside*

History 331b. The Two Reformations, 1517-1598 (3-0-3).

A survey of the Protestant and Catholic Reformations of the sixteenth century. *Mr. Garside*

History 340a. History of American Foreign Policy, 1775-1900 (3-0-3).

American foreign policy and its relation to the foreign policies of other nations, with emphasis on the domestic political forces shaping governmental decisions. Among the topics considered are the diplomacy of the American Revolution, the perils of independence, the origins of the War of 1812, continental expansion, and the crisis of 1890's. Prerequisite: consent of the instructor. Not offered 1968-69. *Mr. Neu*

History 341b. History of American Foreign Policy, 1900 to the Present (3-0-3).

A continuation of History 340a. This portion of the course covers the rise of America to world power during the era of Theodore Roosevelt, World War I and American intervention, World War II, and the growth of rival Western and Communist blocs. Prerequisite: consent of the instructor. Not offered 1968-69. *Mr. Neu*

History 345a. Medieval and Early Modern Russia (3-0-3).

A survey of main developments in Russian history from the Kievan period to the reign of Catherine the Great. Admission with the consent of the instructor. *Mr. Stokes*

History 346b. Russia in the Nineteenth Century (3-0-3).

Russian history from accession of Alexander I to the Bolshevik Revolution. Admission with the consent of the instructor. *Mr. Stokes*

History 351b. Europe, 1814-1870 (3-0-3).

In the first part of the course the intellectual, religious, economic, social, diplomatic, and political trends of the period between 1814 and 1847 are examined. Then the revolutionary movement of 1848-49, the reign of Napoleon III, the unification of Italy, the unification of Germany, and the Franco-Prussian war will be studied. *Mr. Rath*

History 355a, b. History of American Foreign Policy since 1890 (3-0-3, each sem.).

Largely a discussion course focusing on major problems in American foreign policy. Among topics considered the first semester are the rise of America to world power, World War I and American intervention, and the diplomacy of the 1920's. The second semester covers American isolationism in the 1930's, World War II, the China tangle, and the growth of rival Western and Communist blocs. Open to students who have not taken History 340a and 341b only with the consent of the instructor. *Mr. Neu*

History 360a. The History of England to 1714 (3-0-3).

This course will survey English history from the Norman Conquest, emphasizing

the growth of responsible government and the preconditions for an industrial society. *Mr. Wiener*

History 361b. The History of England since 1714 (3-0-3).

Emphasis will be given to the rise and development of industrial society, the growth of democracy, and the adjustment of English ideas and institutions to these phenomena. *Mr. Wiener*

History 365a. Nineteenth Century Britain (3-0-3).

This course will examine the "two revolutions"—industrial and democratic—and their impact on British society. The emphasis will be on the changing character of British life, and more specifically, on the formation of the "Victorian Compromise." Not offered in 1968-69. *Mr. Wiener*

History 366b. Twentieth Century Britain (3-0-3).

A continuation of History 365a. Some of the chief topics to be considered are the disintegration of "Victorianism," the problems of industrial "middle age," the growth of a welfare state, the decline in world power, and the nature of British society in the 1960's. Not offered in 1968-69. *Mr. Wiener*

History 370a. Europe, 1648-1789 (3-0-3).

A study of political, economic and intellectual developments in Europe, placing particular emphasis upon French history, leading thinkers of the Age of Reason, and the nature of Enlightened Despotism. *Mr. Barker*

History 371b. The French Revolution and the Era of Napoleon (3-0-3).

A study of the origins and course of the Revolution, the nature of the Napoleonic regime, and the spread of revolutionary ideas to other countries of Europe. *Mr. Barker*

History 375a. Germany Since the Middle Ages (3-0-3).

The first semester of this course is concerned with the history of Germany from the Middle Ages to the nineteenth century. Special attention is devoted to reading of major historical works and to outstanding historiographical controversies, and the whole subject is treated in the broad perspective of comparative history. *Mr. Loewenheim*

History 376b. Germany Since the Middle Ages (3-0-3).

The second semester of this course is devoted to the history of Germany from the Bismarckian era to the present. Special attention is devoted to reading of major historical works and to outstanding historiographical controversies, and the whole subject is treated in the broad perspective of comparative history. *Mr. Loewenheim*

History 380a, b. American Economic History (3-0-3, each sem.).

A study of the economic history of the United States from the colonial period through the Second World War. Examination of principal economic trends will be supplemented by histories of individual firms and business leaders. Open to qualified students after consultation with the instructor. Not offered in 1968-69. *Mr. Galambos*

History 390b. History of the American West (3-0-3).

This course traces the westward movement from its beginning on the Atlantic seaboard to its culmination on the Pacific. Most attention is given to the history, institutions, and problems of the Trans-Mississippi West, with special emphasis on Texas and the Great Plains. Prerequisite: History 110a,b. *Mr. Muir*

History 395a, b. A History of the South (3-0-3, each sem.).

A study of life and economy of the Southern people from the colonial period. Primary emphasis is placed on the period to 1877. Prerequisite: History 110a,b. Not offered in 1968-69. *Mr. Vandiver*

History 404a, b. Senior Thesis (0-0-3, each sem.).

A limited number of Seniors majoring in the department are allowed to write a thesis of fifteen to twenty-five thousand words on a subject to be approved in advance by their departmental advisers. Open to students in the accelerated M.A. program and to other well-qualified students with special permission. Students must take both History 404a and 404b in order to gain credit. *Staff*

History 411a. Jeffersonian and Jacksonian Democracy (3-0-3).

A study of the development of the United States from 1789 to 1848 with particular emphasis on political ideas and practices. Offered, with additional requirements, for graduate credit. *Mr. Higginbotham*

History 430a, b. Topics in Ancient and Medieval Intellectual History (3-0-3, each sem.).

This course deals with selective phases of classical and medieval thought based on the cultural monuments of antiquity and the Middle Ages. Intensive reading and reports on special aspects of the field. Prerequisite: History 200a and 201b. Also offered as Classics 430a,b. Not offered in 1968-69. *Mr. Lear*

History 440a, b. Social and Economic History of Europe in the Middle Ages (3-0-3, each sem.).

A seminar covering selected problems in the social and economic history of Europe from the period of the late Roman Empire to the close of the Middle Ages. Prerequisite: consent of the instructor. *Mrs. Drew*

History 445b. Maritime and Naval History (3-0-3).

The story of man's activity on the sea, with attention to commercial progress from early times and its effect on the development of nations; exploration and colonization; and the influence of sea power upon history. *Mr. Craig*

History 450a. Contemporary History (3-0-3).

A survey of current world affairs, with lectures and readings on the background of present-day policies and events. *Mr. Craig*

History 453a. History of Southeastern Europe, Fourteenth to the Eighteenth Century (3-0-3).

This course will deal with the Byzantine heritage, the Ottoman conquest and its impact upon the peoples of the Balkans, and the internal political and cultural history of the Rumanians, South Slavs, Greeks, and Albanians down to 1804. Admission with the consent of the instructor. Not offered in 1968-69. *Mr. Stokes*

History 454b. History of Southeastern Europe Since 1804 (3-0-3).

This course will deal with the rise of nationalism and the formation of national states in the Balkans, the decline of the Ottoman Empire, and the political and cultural history of Rumania, Yugoslavia, Bulgaria, Greece, and Albania in the nineteenth and twentieth centuries. Admission with the consent of the instructor. Not offered in 1968-69. *Mr. Stokes*

History 455a. Modern Europe, 1871-1914 (3-0-3).

The subject of this course is the political, diplomatic, and cultural history of Europe from the proclamation of the German Empire to the outbreak of the First World War. Prerequisite: History 100a,b. *Mr. Loewenheim*

History 456b. Modern Europe, 1914 to the Present (3-0-3).

The second semester of this course is concerned with the political, diplomatic, and cultural history of Europe from the First World War to the present. *Mr. Loewenheim*

History 465a. Colonial America to 1754 (3-0-3).

A study of the growth of society, thought, and politics in the English colonies of

North America. Lectures, discussions, and papers; admission with the consent of the instructor. *Mr. Gruber*

History 466b. The American Revolution, 1754-1789 (3-0-3).

A study of the origins and implications of the American Revolution, emphasizing constitutional, social, and political developments. Lectures, discussions, and papers; admission with the consent of the instructor. *Mr. Gruber*

History 475a. The History of Central Europe (3-0-3).

A brief summary of the main phases of the history of Central Europe from ancient times to the present. *Mr. Rath*

History 476b. Colloquium in Central European History (3-0-3).

A critical examination of the main literature in the field. Prerequisite: History 475a. *Mr. Rath*

History 495a, b. Civil War and Reconstruction (3-0-3, each sem.).

A study of the rise of sectionalism, the secession crisis, United States versus Confederate States, and economic and social consequences of the war. Emphasis is placed on the years 1861-1865. Prerequisite: History 110a,b. *Mr. Vandiver*

History 500a, b. Historical Research (0-0-3, each sem.).

Master's thesis. Students must take both History 500a and 500b in order to gain credit. *Staff*

History 509b. Reading and Research in the Jeffersonian and Jacksonian Periods (3-0-3).

A weekly seminar for graduate students stressing written reports in reading and the preparation of a paper based upon research in primary materials. *Mr. Higginbotham*

History 510a. Directed Reading in American History (0-0-3).

For graduate students only. *Staff*

History 511b. Directed Reading in American History (0-0-3).

Continuation of History 510a. *Staff*

History 515a. General Reading in American History (0-0-3).

An independent reading course designed to give students of graduate level a knowledge of the most significant works in the general field of Americon history as distinct from those in any specialized area. *Staff*

History 516b. General Reading in American History (0-0-3).

Continuation of History 515a.

History 520a. Directed Reading in Medieval History (0-0-3).

For graduate students only. *Staff*

History 521b. Directed Reading in Medieval History (0-0-3).

Continuation of History 520a. *Staff*

History 530a. Directed Reading in Modern European History (0-0-3).

For graduate students only. *Staff*

History 531b. Directed Reading in Modern European History (0-0-3).

Continuation of History 530a. *Staff*

History 535b. Bibliographical Guides in United States History (3-0-3).

A seminar for graduate students in the construction and use of bibliographies for research in United States history. *Mr. Muir*

History 545a, b. Historiography (3-0-3, each sem.).

Seminar in historiography and the philosophy of history for graduate students.

History 550a, b. Studies in the History of the Atlantic Community (3-0-3, each sem.).

A seminar on the origins, character, and development of the Atlantic Community, with special emphasis on its political, diplomatic, and cultural history since the eighteenth century. Prerequisite: History 455a and 456b or equivalent. Open to graduate students and to qualified Seniors with special permission.

Mr. Loewenheim

History 555a, b. Seminar in German History (3-0-3, each sem.).

Frederick the Great, Bismarck, and Hitler. Studies in the history of the German political tradition. Prerequisite: History 455a and 456b or the equivalent. Qualified undergraduates may be admitted by special permission. Not offered 1968-69.

Mr. Loewenheim

History 565a, b. Seminar in Austrian History (3-0-3, each sem.).

Selected topics in nineteenth and twentieth century Austrian history. Prerequisite: History 350a and 351b or 455a and 456b or the equivalent. Qualified undergraduates may be admitted by special permission. *Mr. Rath*

History 570a, b. Seminar in the First World War (3-0-3, each sem.).

Studies in the causes of World War I and the course of the war itself. Open to properly qualified graduate students after consultation with the instructor.

Mr. Vandiver

History 575b. The Great Tradition in European Historical Writing from the Age of Gibbon to the Present (3-0-3).

A seminar-research course examining the main currents of European historical writing since the eighteenth century. Special attention will be devoted to such seminal figures as Gibbon, Ranke, Macaulay, Treitschke, Burckhardt, Acton, Croce, Meinecke, Namier, and Lefebvre, and to a number of leading contemporary historians. For graduate students and qualified undergraduate students by permission. Graduate students are expected to have a reading knowledge of French or German. Not offered in 1968-69. *Mr. Loewenheim*

History 580a. Seminar in the American Revolution (3-0-3).

A research seminar in the American Revolution, open only to graduate students with the consent of the instructor. *Mr. Gruber*

History 590b. Seminar in Western American History (3-0-3).

This course includes a study of the leading authorities in Western American history, training in the critical examination of source material, and original research in selected topics of Western history. Open to graduate students and to Seniors who show a proficiency in history, after consultation with the instructor.

Mr. Muir

History 595a, b. Topics on Confederate History (3-0-3, each sem.).

This seminar is devoted to original research in various phases of the history of the Southern Confederacy, 1861-1865. Open to properly qualified students after consultation with the instructor. *Mr. Vandiver*

History 600a, b. Historical Research (0-0-3, each sem.).

Doctoral dissertation. *Staff*

History of Art

(*See* pages 189-190)

Humanities

Humanities 100a, b. Leading Minds in Western Civilization (3-0-3, each sem.).

A course in intellectual history. It is a study of the most important ideas in Western European and American civilization studied through the lives and works of understanding people from antiquity to the modern world. *Mr. Tsanoff*

Humanities 101a, b. The Classical Foundations of Political Thought (3-0-3, each sem.).

An examination of the historical and philosophical influences underlying the political theory and institutions of the classical world. The first semester is devoted primarily to the political and constitutional history of ancient Greece and Rome with the purpose of analyzing the governing systems and structures. The second semester deals with basic political ideas and problems of the ancient world such as natural law, justice, citizen and subject, republic, god-kingship, slavery, equality, and sovereignty. *Mr. Lear*

Humanities 300a. The Beginnings of Modern Thought in the Renaissance (3-0-3).

A historical and critical outline of the transition from medieval to modern thought: an examination of the main representative minds of Renaissance culture in its many aspects: philosophical, scientific, literary, social-political. *Mr. Tsanoff*

Humanities 300b. The Idea of Progress in History (3-0-3).

A historical and systematic inquiry into the growing vitality of social values. In the first part of the course the idea of progress is traced in its historical development since classical antiquity. The second part of the term is devoted to an appraisal of the belief in social progress by an examination of the reasons for and against it provided by the evidence in the various social institutions. *Mr. Tsanoff*

Humanities 310a, b. Autobiography: Its Personal and Social-Historical Aspects (3-0-3, each sem.).

A study of the self-recorded lives of great men and women as intimate expressions of personal character and achievements and as individual reflections of various societies and ages from antiquity to modern times. *Mr. Tsanoff*

Italian

(*See* pages 137-140)

Latin

(*See* pages 137-139)

Linguistics

Linguistics 401a. Introduction to Descriptive Linguistics (3-0-3).

An introduction to language and linguistics giving consideration to basic linguistic concepts and techniques. *Mr. Copeland*

Linguistics 402b. Special Topics in Linguistics (3-0-3).

Topics will be drawn from the areas of historical linguistics, phonetics, phonemics, morphology, syntax, and semantics. *Mr. Copeland*

Mathematics

Professors Bochner, Bray, Connell, Curtis, *Chairman,*
Rachford, and Ulrich
Visiting Professor Koecher
Associate Professors Jones, O'Neil, and Resnikoff
Assistant Professors Bell, Freeman, Gersten, Harvey, Hempel,
Jacobs, Polking, Rector, Wells, and Yap
G. C. Evans Instructors Chern, Goldman, Lees, Leonard,
and Morgan

Undergraduate Program

Requirements for an Undergraduate Major. It is permissible to major in mathematics in either the science-engineering program or the humanities (academic) program. In either case, twelve courses in mathematics are required. Three choices of courses are permissible. The first is Mathematics 100a,b, 200a,b or 210a,b, 300a, 340a, 370a,b, and two of the following combinations, Mathematics 400a and 410b, 415a,b, 435a,b, 465a,b, and 470a,b. The second is Mathematics 220a,b, 310a,b, 340a,b, 371a,b, 415a,b, or 525a,b, 445a,b, or 465a,b. The third is Mathematics 220a,b, 340a,b, 371a,b, 445a,b, 465a,b and two courses at the 500 level. Other programs may be permitted, but each program differing from those just listed requires written approval by the chairman of the Mathematics Department. An outstanding student in Mathematics 100a,b, or 200a,b may, upon recommendation from his professor, be admitted into an honors section such as Mathematics 310a,b. In the case of a double major (physics and mathematics, for example) ten courses in mathematics are acceptable to the department.

Graduate Program

Admission to graduate study in mathematics will be granted to a limited number of students who have indicated ability for advanced and original work. It normally takes one or two years after the bachelor's degree to obtain an M.A. degree and three or four years to obtain a Ph.D. An M.A. is not a prerequisite for the Ph.D.

A number of graduate assistantships and fellowships are available

and will be awarded on the basis of merit. The recipients of such aid are expected to devote about six hours a week to duties in the department.

The Qualifying Examinations

The qualifying examinations in mathematics are conducted as follows:

1. Examinations are given during the first week of the second semester of each year.
2. Students in their second year of graduate study are expected to take the *General Examinations* during that week. Also, well-qualified first-year graduate students may take these examinations. Students in their third year of graduate study are expected to take a *Special Examination* during that week.
3. There are three General Examinations covering the basic material in algebra, analysis and topology as specified in item 7 below. The Special Examination is given in the student's choice of one of the fields of algebra, analysis or topology.
4. The Special Examination is for the purpose of determining how much the student has learned of his chosen field of mathematics, and there is no specified outline of topics to be covered.
5. The General Examinations will be considered as qualifying for the Master's degree. Passing the General Examinations is a prerequisite for taking the Special Examination. Both General and Special Examinations together constitute the *qualifying examination for the Ph.D.*
6. The General Examinations will consist of three oral examinations, each by at least two faculty members, one in each of the three areas—analysis, topology, algebra. The examinations will be to determine if the student is familiar with the basic concepts and can work with them. Ability to simply recite the material listed in item 7 is no guarantee of success.
7. There are detailed syllabi for the areas to be covered by the General Examination, but the following will serve as a rough guide:

Algebra:	Contents of Herstein plus Math 470a.
Analysis:	Differential Equations—Coddington
	Real Variable—Royden
	Complex Variable—Hille
	Either Math 415a or Math 525a
Topology:	Contents of Dugundji
	Math 445a or Math 465a

Requirements for the Master's Degree.

1. *To qualify as a candidate* for the Master of Arts degree, the prospective candidate must have:
   a. Done satisfactory work (2- or better) in at least eight courses

acceptable to the department, exclusive of Mathematics 600. This is to mean that the grades in those courses completed during previous years, and the grades in those courses taken during the year in which the petition for candidacy is filed are satisfactory (2- or better).

If a student's candidacy is approved under the above conditions, but his grades at the end of the year in which his candidacy is approved no longer meet these conditions, his candidacy for the master's degree is automatically revoked.

b. Passed the General Examinations.
c. Passed an examination in at least one approved foreign language (French, German, or Russian).

2. *The remaining requirements* for the master's degree are:
   a. The writing of an original thesis acceptable to the department while enrolled in Mathematics 600 (thesis).
   b. The passing of a final oral examination on the thesis.
   c. Any other conditions required by the general rules of the University.

   N.B. For students who transfer to Rice while engaged in a program of graduate study, transfer of course credits will be allowed only when approved by both the department and the Graduate Council.

Requirements for the Doctor's Degree.

1. *To qualify as a candidate* for the doctorate, the prospective candidate must have:
   a. Completed satisfactorily (with a grade of 2- or better) at least twelve courses numbered 400 or higher, exclusive of Mathematics 600 (thesis). The selection of these twelve courses must be satisfactory to the department. For students who transfer to the University in the middle of their graduate work, transfer of grades will be allowed only when approved by both the department and the Graduate Council.
   b. Passed both the General and Special Examinations as described above.
   c. Passed examinations in two approved foreign languages (French, German, or Russian).
2. *The remaining requirements* for the doctorate are:
   a. Satisfactory work (2- or better) in at least fourteen semester-courses numbered 400 or higher, exclusive of Mathematics 600; these fourteen courses include twelve under the qualifying requirements.
   b. The writing of an original thesis acceptable to the department while enrolled in Mathematics 600 (thesis).
   c. The passing of a final oral examination on the thesis.

d. Any other conditions required by the general rules of the University.

COURSES

Mathematics 100a, b. Elementary Analysis (4-0-4, each sem.).

Limits, differentiation, and integration are introduced early in the year, and applications are discussed. Other topics include a careful definition of trigonometric and exponential functions, analytic geometry, partial differentiation, vector methods. The course is designed to give the student an introduction not only to the applications of the calculus but also to the techniques of mathematical reasoning; it (or Mathematics 220) is the basic course in mathematics and is required of all Freshmen enrolled in the science-engineering curriculum and may be elected by students in the humanities (academic) curriculum.

Mathematics 101a, b. Fundamental Concepts of Mathematics (3-0-3, each sem.).

Elementary logic, the real number system, introduction to differential and integral calculus. Emphasis is on the abstract nature of mathematical reasoning, and the purpose of the course is to indicate the place of mathematics among the several branches of knowledge. This course is open only to students in the humanities curriculum who do not plan to continue their study of mathematics beyond one year.

Mathematics 200a, b. Advanced Analysis (3-0-3, each sem.).

Least upper bounds, limits, definite integrals, improper integrals, infinite series, multiple integrals, line and surface integrals, divergence theorem and Stokes' theorem, with applications to physical problems. Required of all science-engineering majors who do not take Mathematics 210 or 220. Students with considerable facility in mathematical reasoning should enroll in Mathematics 210. Prerequisite: Credit for Mathematics 100 or permission of the department.

Mathematics 210a, b. Advanced Analysis (3-0-3, each sem.).

The course has the same scope as Mathematics 200 but is more complete and rigorous. Prerequisite: Written permission of the department.

Mathematics 220a, b. Analysis (4-0-4, each sem.).

An honors course for Freshmen covering the same material as Mathematics 100 and 210. Registration by permission of the department. Selection is made on the basis of either the CEEB Advanced Placement Examination on analytic geometry and calculus or a qualifying examination given by the Mathematics Department at the beginning of the school year. The students are expected to know the techniques of differentiation, integration, areas, volumes, max-min problems, etc., in advance so that emphasis can be placed on the theoretical aspects.

Mathematics 300a, b. Differential Equations (3-0-3, each sem.).

Integration of differential equations of first order by elementary methods, geometry of integral curves, existence and uniqueness theorems for differential equations, properties of linear equations, oscillation and separation theorems, theory of regular singular points, special functions of mathematical physics. Fourier analysis, orthogonal systems, expansion theorems, boundary-value problems. Prerequisite: Mathematics 200a,b, 210a,b, or 220a,b.

Mathematics 310a, b. Functions of Several Variables (3-0-3, each sem.).

An honors course following Mathematics 220. Linear algebra is developed as needed. Differentiation of functions from open subsets of Euclidean space to Euclidean space is studied; max-min problems, Lagrange's multiplier rule, etc. are considered in this setting. Differential forms on Euclidean spaces and on manifolds are considered. Lebesgue integration for such forms is developed. Vector calculus is considered as a special case and applications to problems of dynamics are made. Prerequisite: Mathematics 220a,b.

Mathematics 335a. Numerical Analysis (3-0-3).

Computationally oriented studies of numerical techniques: polynomial and other approximations, interpolation, finite difference methods, numerical solution of ordinary and partial differential equations, solution of non-linear equations, iteration. Intended primarily for non-mathematics majors.

Mathematics 336b. Linear Algebra (3-0-3).

Finite dimensional vector spaces, linear transformations and matrices. Analysis oriented toward related computable processes (e.g., solution of linear systems, matrix inversion, construction of eigensystems) and toward problem conditions, i.e., the sensitivity of solutions to changes introduced in the data or by rounding errors in computations. Intended primarily for non-mathematics majors.

Mathematics 340a, b. Topology (3-0-3, each sem.).

General topological spaces, compactness, paracompactness, metric spaces, completeness, uniform continuity, simplicial complexes, CW complexes, mapping cylinders, the well-ordering principle, function spaces, the compact-open topology, covering spaces, fiber spaces, the fundamental group, and an introduction to homology and homotopy groups. Some mathematical maturity will be necessary. Prerequisite: One of Mathematics 200a,b, 210a,b, 220a,b, 310a,b, or consent of instructor.

Mathematics 360a, b. Probability and Statistics (3-0-3, each sem.).

Conditional probability, Bernoulli's theorem, law of large numbers, distributions, central-limit theorem, correlation, large and small sample theory, goodness of fit, testing statistical hypotheses, design of experiments. Prerequisite: Mathematics 200a,b, 210a,b, or 220a,b.

Mathematics 370a, b. Algebra (3-0-3, each sem.).

An introduction to the basic structures of algebraic systems: groups, rings, fields, and their morphisms. Vector spaces are studied extensively, including matrices, determinants, characteristic values, canonical forms, multilinear algebra. Basis theorem of abelian groups and modules is established. Prerequisite: Mathematics 200a,b or 210a,b.

Mathematics 371a, b. Algebra (3-0-3, each sem.).

An honors course in algebra including the material of Mathematics 370a,b, finite group theory, and Galois theory. Prerequisite: Mathematics 310a,b.

Mathematics 400a. Complex Variable Theory (3-0-3).

Linear transformations, holomorphic functions, power series, complex integration and the Cauchy integral, residue calculus.

Mathematics 400b. Complex Variable Theory (3-0-3).

An assortment of topics such as normal families, the Riemann mapping theorem, boundary correspondence, univalent functions, entire functions, and meromorphic functions.

Mathematics 401b. Applied Complex Variable Theory (3-0-3).

A selection of topics such as ordinary differential equations in the complex domain, special functions of mathematical physics, conformal mapping, the Laplace transform, and a more extensive treatment of the calculus of residues.

Mathematics 410b. Real Variable Theory (3-0-3).

Lebesgue and Daniell theory of measure and integration.

Mathematics 415a, b. Partial Differential Equations (3-0-3, each sem.).

Cauchy-Kovalevskaya theorem, classification of partial differential equations, first-order hyperbolic systems, harmonic functions and potential theory, Dirichlet and Neumann problems, the Dirichlet principle, integral equations and the Fredholm

alternative, hyperbolic equations, energy estimates, parabolic equations. Properties of solutions of elliptic and parabolic equations.

Mathematics 435a, b. Numerical Analysis (3-0-3, each sem.).

Approximate integration and differentiation by finite differences, interpolation, functional approximation, linear and nonlinear algebraic equations, eigenvalues, approximate solution of ordinary and partial differential equations. Prerequisite: Mathematics 300a,b.

Mathematics 445a, b. Algebraic Topology (3-0-3, each sem.).

This course develops homotopy theory, theory of fiber spaces, singular homology and cohomology. Theorems of Hurewicz and Whitehead are established. Spectral sequences are studied and used to analyze fiber spaces. Serre C-theory is developed. Geometrical applications are made in studying fixed-point theory, imbedding problems, and vector field problems. Prerequisites: Mathematics 340a,b and one of Mathematics 220a,b, 310a,b, 370a,b, or 371a,b.

Mathematics 465a, b. Differential Geometry (3-0-3, each sem.).

Differentiable manifolds. Stokes' theorem and deRham's theorem. Fundamental theorem of local Riemannian geometry, manifolds in Euclidean spaces, Lie groups, vector space bundles, theory of affine connections.

Mathematics 470a, b. Algebra II (3-0-3, each sem.).

Finite groups, Galois theory, and representation theory are developed. Special topics are included according to the instructor's interest. Prerequisite: Mathematics 370a,b.

NOTE: *It will be observed that the numbers on the following courses come in groups of five. Each group represents one field in mathematics. If two courses in one group are given in the same year, then two of the five possible numbers will be used. If a student takes several courses in one group, they will be recorded with different numbers from the group.*

Mathematics 500-504. Advanced Complex Variable Theory (3-0-3, each sem.).

Special studies in complex variable theory; typical topics are normal family theory, conformal mapping of multiply-connected domains, univalent functions, Nevanlinna theory of distribution of values for entire and meromorphic functions, boundary behavior of holomorphic and meromorphic functions, Riemann surfaces, uniformization, Banach spaces of holomorphic functions, several complex variables,

Mathematics 505-509. Topics in Analysis (3-0-3, each sem.).

Typical topics include Dirichlet series, singularities of Taylor series, approximation theory, constructive theory of functions, harmonic analysis, analytic number theory, infinitely differentiable functions, asymptotic representations, theory of composition, Tauberian theorems, moment problems, and closure theorems.

Mathematics 510-514. Topics in Real Variable Theory (3-0-3, each sem.).

Typical topics are trigonometric series, Fourier integrals, the use of Banach spaces in classical and functional analysis, Orlicz spaces, and fractional integration.

Mathematics 515-519. Topics in Partial Differential Equations (3-0-3, each sem.).

Typical topics include singular integral operators, Hörmander's theory of linear differential operators, abstract Cauchy problems, elliptic equations of higher order, parabolic equations, not-well-posed problems, and *a priori* estimates for hyperbolic equations.

Mathematics 520-524. Topics in Probability Theory (3-0-3, each sem.).

Discrete and continuous parameter stochastic process, Markov processes, martingales, stochastic potential theory.

Mathematics 525a, b. Functional Analysis (3-0-3, each sem.).

Topological linear spaces, theory of distributions, Banach algebras, harmonic analysis.

Mathematics 526-529. Topics in Functional Analysis (3-0-3, each sem.).

Generalized functions in sense of Gelfand and Shilov, semigroups, Banach spaces of analytic functions and invariant subspaces, singular integral operators, and interpolation of operators.

Mathematics 530-534. Topics in Applied Mathematics (3-0-3, each sem.).

Typical topics include the Laplace transform and its application to problems in differential equations and complex variable theory, special functions of mathematical physics, methods of mathematical physics, calculus of variations, numerical analysis.

Mathematics 535-539. Topics in Potential Theory (3-0-3, each sem.).

Potential theory in n-dimensional Euclidean space, harmonic and superharmonic functions, Poisson integral, polar sets and capacity, Dirichlet problem, Green's function, Martin boundary.

Mathematics 540-544. Topics in Point-Set Topology (3-0-3, each sem.).

Typical topics include general point-theoretic topology, topology of 3-space, imbedding problems, topology of manifolds, decomposition spaces and mappings, knot theory, dimension theory, and theory of retracts.

Mathematics 545-549. Topics in Algebraic Topology (3-0-3, each sem.).

Material studied will include topics such as extraordinary homology and cohomology theories, Lie Groups, Bott periodicity, the Steenrod algebra, higher order cohomology operations, characteristic classes, sheaf theory, homotopy theory, vector fields on manifolds, imbedding problems.

Mathematics 550-554. Topics in Combinatorial Topology (3-0-3, each sem.).

Whitehead's theory of regular neighborhoods, simple homotopy type and torsion, generalized Poincaré conjecture, combinatorial imbeddings of manifolds, triangulated manifolds and the Hauptvermutung, study of combinatorial manifolds of dimensions three and four.

Mathematics 555-559. Topics in Differential Topology (3-0-3, each sem.).

Topology of differential manifolds, fiber bundles, tubular neighborhood theorem, Whitney imbedding theorem, transverse regularity theorem, diffeotopy extension theorem. Special topics: structure of manifolds and manifold pairs, s-cobordism theorem, Novikov's theorem, differential structures on spheres, cobordism theories, theory of immersions, characteristic classes, handle-bodies, smoothing theory, Cairns-Hirsch theorem, obstruction theory, Morse theory, infinite dimensional manifolds, and the calculus of variations, Atiyah-Singer theorem, Nash theory.

Mathematics 600. Thesis.

Mathematics Colloquium.

The colloquium usually meets one afternoon each week to allow the exposition of original investigations by visitors, faculty members, or students.

Mathematical Sciences

Professors de Figueiredo, Horn, *Chairman*, Jackson, Pfeiffer, Rachford, Salsburg, Thrall, Trammell, and Wang
Associate Professors S. Davis, Ingram, Schmaedeke, and Young
Assistant Professors Bowen, Dyson, Huband, Lutes, and Sibert

Admission to the M.S. and Ph.D. programs is open to any engineering, science, or mathematics major who has sufficient qualifications and is willing to supplement his background in either mathematics or one of the engineering and science areas. Candidates for an advanced degree have to pass a qualifying examination in which competence in mathematics and in one area of the physical or behavioral sciences is tested.

COURSES

Mathematical Sciences 410. Linear Algebra (3-0-3).

Discussion of elementary properties of finite dimensional real vector spaces. Also offered as Engineering 471. For a complete description see page 156.

Mathematical Sciences 430. Complex Variables (3-0-3).

Discussion of the elementary concepts of complex variable theory. Also offered as Engineering 472. For a complete description see page 156.

Mathematical Sciences 450a. Numerical Analysis I (3-0-3).

Numerical solution of linear and nonlinear equations. Numerical linear algebra. Interpolation, roots of polynomials, rounding errors, iterative processes. Also offered as Engineering 572.

Mathematical Sciences 451b. Numerical Analysis II (3-0-3).

Numerical solution of ordinary and partial differential equations.

Mathematical Sciences 471. Linear Programming (3-0-3).

Formulation of managerial and technical problems; Simplex method; revised simplex method; duality theory and applications; transportation problems; decomposition techniques.

Mathematical Sciences 480a. Probability Theory (3-0-3).

This course is also offered as Engineering 475. See page 156 for a complete description.

Mathematical Sciences 481b. Mathematical Statistics and Random Processes (3-0-3).

A continuation of Mathematical Sciences 480a. Also offered as Engineering 476.

Mathematical Sciences 482a. Probability Theory and Random Processes (3-0-3).

This course includes topics similar to those covered in Mathematical Sciences 480. More emphasis will be given to subjects related to random sequences.

Mathematical Sciences 511b. Group Theory for Chemists and Physicists (3-0-3).

The basic definitions and theorems of group theory are first summarized with a

minimum of theoretical development. The representation theory of groups, the construction of character tables, will be presented in some detail followed by a number of applications of group theory to quantum mechanics, chemical problems, and combinatorial problems.

Mathematical Sciences 512b. Tensor Analysis (3-0-3).

Multilinear algebra including exterior and symmetric algebra. Tensor fields on Euclidean manifolds. Prerequisite: Mathematical Sciences 410.

Mathematical Sciences 522. Functional Analysis (3-0-3).

Discussion of normed linear spaces, topological vector spaces, linear operators in locally convex topological vector spaces, theory of distributions, applications.

Mathematical Sciences 541a, b. Integral Equations and Partial Differential Equations (3-0-3, each sem.).

Origin of integral equations, solutions by iterations, symmetric equations and completely continuous operators. Cauchy's problem and classification. Existence and uniqueness theorems for partial differential equations. Applications to problems in science and engineering.

Mathematical Sciences 545. Fundamentals of Nonlinear Systems (3-0-3).

Intrinsic properties of nonlinear deterministic and random systems including stability, observability and controllability. An introduction to approximation theory and its application to nonlinear estimation. Also offered as Chemical Engineering 517, Economics 527, and Electrical Engineering 517.

Mathematical Sciences 563. Automata and Programming Theory (3-0-3)

A general investigation of algorithmic processes. Also offered as Electrical Engineering 522. See page 172.

Mathematical Sciences 565. Systems Programming (3-0-3).

Design and implementation of programming systems for digital computers. Also offered as Electrical Engineering 622. For a complete description see page 173.

Mathematical Sciences 567. Non-numerical Programming (3-0-3).

Non-numeric applications of digital computers drawn from current literature will be discussed. Also offered as Electrical Engineering 624, described on page 173.

Mathematical Sciences 571. Fundamentals of Optimization Theory (3-0-3)

A discussion of the mathematical problems encountered when searching for the best element in a given set. Also offered as Chemical Engineering 518, Economics 528, and Electrical Engineering 518. See page 171.

Mathematical Sciences 573. Advanced Mathematical Programming (3-0-3)

Theory, computational methods, and applications of various advanced programming models. Also offered as Chemical Engineering 519, Economics 529, and Electrical Engineering 519. See page 171.

Mathematical Sciences 576a, b. Topics in the Mathematical Theory of Optimal Control (3-0-3, each sem.).

Liapunov's theorem on the range of vector measures, Pontryagin's maximal principle, bang-bang principles, existence theory, controllability, synthesis of optimal controls, relaxed control problems, direct methods (construction of minimizing sequences), multiplier rules in locally convex spaces and application to the optimal control of distributed parameter systems. Prerequisite: Mathematics 410, Mathematical Sciences 443.

Mathematical Sciences 592a, b. Seminar in Applied Mathematics (3-0-3, each sem.).

Mathematical Sciences 596a, b. Special Topics in Mathematical Sciences (3-0-3, each sem.).

Mechanical Engineering

(*See* pages 175-184)

Military Science

PROFESSOR WENDT, *Chairman*
ASSISTANT PROFESSORS RODRIGUEZ AND FINCH

Military Science 101a. Organization of the Army; Individual Weapons and Marksmanship (1-1-1).

Organization of the squad, platoon, and company of the infantry battalion emphasizing specific duties and responsibilities of key personnel. The integration of small units into larger teams and general design of military organization to fit missions to be performed. Functioning, care, and maintenance of the caliber .30 rifle with stress on marksmanship training and good shooting habits.

Military Science 102b. U. S. Army and National Security (1-1-1).

A brief presentation of national defense policy and world-wide commitments that require support of the armed forces. The mission and capabilities of the U. S. Army Reserve and National Guard; the missions, capabilities, and interdependence of the U. S. Air Force, U. S. Navy, and U. S. Army. The role of the U. S. Army in conceivable types of warfare.

Military Science 201a. American Military History (2-1-2).

Survey of American military history from the origin of the U. S. Army to the present with emphasis on the factors which led to the organizational, tactical, logistical, operational, strategical, and social patterns found in the present-day army.

Military Science 202b. Map and Aerial-Photograph Reading; Introduction to Basic Tactics (2-1-2).

Application of basic principles of map and aerial-photograph reading to military science. Organization, composition, and mission of basic military teams to include rifle squad, patrols, and small infantry-tank teams. Combat orders and formations, cover and concealment, patrolling, field fortifications, and camouflage.

Military Science 301a. Military Teaching Principles and Branches of the Army (2-1-2).

Educational psychology as it pertains to the five stages of instructional technique and the importance of each, including practical application to military instruction. The role of each of the combat arms and services of the Army. Conduct of guerrilla warfare and counterinsurgency operations.

Military Science 302b. Military Leadership: Small-Unit Tactics and Communications (3-1-3).

Responsibilities and basic qualities of a leader, objectives of leadership, leadership principles and techniques, functional role of the leader, and special problems of military leadership. Principles of offensive and defensive combat and their application to the units of the infantry division. Familiarization with the means and principles of Army communications.

Military Science 401a. Military Operations: Logistics and Administration. (3-1-3).

Organization and functions of a military staff, using the infantry division staff as a model, relationship between commanders and the staff and the relationship between subordinate units and the staff; the army logistics system, including supply, maintenance, evacuation, and troop movement; the role of the officer in Army administration, to include familiarization with Department of Army publications and forms.

Military Science 402b. Military Law; Role of the U. S. in World Affairs; and Service Orientation (2-1-2).

Brief history of military law, the articles of the Uniform Code of Military Justice, nonjudicial punishment, composition and jurisdiction of courts-martial, rules of evidence, and trial procedures; analysis of the major geographical areas of the world with regard to economic power, war potential, and inclination and aptitude for the conduct of war; customs of the service; conduct and code of an officer; responsibilities and obligations of an officer; the Army as a career.

Music

The Shepherd School of Music
Associate Professor Hall
Lecturer Bedford

Opportunity for students to continue their music activity at Rice will be found in the Rice Chamber Orchestra and University and College choruses. They may also arrange for private study of their instrument through the Music office.

Music 300a, b. Orientation and Historical Survey (3-0-3, each sem.).

An investigation into the technical, psychological, and social aspects of music. Prerequisite: Junior standing. *Mr. Hall*

Music 315a, b. Harmony and Sight-Singing (3-0-3, each sem.).

Instruction in the theory and practice of traditional harmony, sight-singing and dictation. The translations of notation into rhythm and sound, and sound into notation. Includes all triads and seventh chords, with inversions and nonchord tones. *Mr. Hall*

Music 415a, b. Advanced Harmony (3-0-3, each sem.).

Advanced work in harmony including chromatic alteration and modulation, modern technics, and original work in small forms. Prerequisite: Music 315 or instructor's permission. *Mr. Hall*

Naval Science

Professor Potter, *Chairman*
Associate Professor Ogier
Assistant Professors Cameron, Latham, Taylor, and Turbeville

Naval Science courses as described will be taken in succession as listed

Naval Science 100a, b. Sea Power and Orientation (1-1-1, each sem.).

This course consists of a one-hour weekly classroom period plus a one-hour

weekly laboratory in which fundamental concepts of sea power, traditions, customs, organization, seamanship, and missions of the Navy are presented. In addition, either History 100a,b (Europe since 1500) or History 110a,b (American History)—both taught by the History Department—is a course requirement for all Freshman N.R.O.T.C. students.

Naval Science 201a. Navigation (3-1-3).

Terrestrial and celestial navigation. Piloting problems, utilizing electronic and visual navigation aids, are studied. Motions of celestal bodies are determined. The celestial sphere concept is utilized in determining position by the employment of spherical trigonometry.

Naval Science 202b. Naval Weapons (3-1-3).

Introduction to naval weapons and space technology. Fire-control systems. Principles of sonar and radar. Guided missiles. Nuclear weapons and radiological defense. Antisubmarine warfare. Amphibious warfare.

Naval Science 301a. Naval Machinery (3-1-3).

Basic principles of and problems in thermodynamics are employed in the study of various power cycles of both main propulsion and auxiliary plants. Steam, internal combustion, and nuclear plants are studied and their energy transformations analyzed. With the emphasis on fundamental principles employed, the student is familiarized with the entire shipboard engineering plant, including electrical systems, refrigeration, compressed-air, and hydraulic systems. Principles of ship stability are studied, including evaluations of transverse and longitudinal stability after damage and weight change.

Naval Science 302b. Naval Operations (3-1-3).

The elements of shipboard operations, including the Rules of the Nautical Road, problems in relative motion, maneuvering ships in formation, and employment of the Striking Force. Fleet communications, with an introduction to electronics countermeasures. The effects of weather on naval operations.

Naval Science 401a. Naval Leadership (3-1-3).

This course consists of one of several appropriate psychology courses offered by the Psychology Department, together with the regularly scheduled Naval Science laboratory and drill period. Psychology may be taken any year.

Naval Science 402b. Principles and Problems of Leadership (3-1-3).

Application of the principles of naval management, naval administration, and leadership.

N.R.O.T.C. students who desire to be commissioned as second lieutenants in the U. S. Marine Corps or Marine Corps Reserve, and whose applications for transfer are accepted, will substitute the following courses during the final two years.

Naval Science 303Ma. Evolution of the Art of War (3-1-3).

Significance of military power. Classic principles of war, analyzed as a foundation for further understanding of military operations by a study of famous battles.

Naval Science 304Mb. Modern Basic Strategy and Tactics (3-1-3).

Basic strategic concepts and principles of offensive and defensive tactics through the battalion level.

Naval Science 403Ma. Amphibious Warfare (3-1-3).

History of amphibious warfare. Development of amphibious tactics. Gunfire support. Planning. Logistics. Administration.

Naval Science 404Ma. Marine Corps Leadership and the Uniform Code of Military Justice (3-1-3).

Development of leadership techniques through a study of the basic psychology of leadership. Uniform Code of Military Justice.

Philosophy

PROFESSORS FULTON, KOLENDA, *Chairman,* AND NIELSEN
VISITING PROFESSOR MANSER
ASSISTANT PROFESSORS AUSTIN, BURCH, AND GIANNONI
INSTRUCTOR HOLIEN

Undergraduate Majors: Philosophy majors will normally be required to take at least eight semesters of upper-division courses. While introductory courses are not required as prerequisite for majoring in philosophy, they are regarded as suitable preparation. All majors will be required to take at least two semesters in the history of philosophy. Regarding other philosophy courses students must consult with members of the department about their program. With departmental approval, qualified upper-classmen may enroll for independent study in Philosophy 401a, 402b, or both.

Requirements for the degree of Doctor of Philosophy include:

(a) The completion with high standing of courses approved by the department.
(b) Ability to use French and German in accordance with the requirements on page 101
(c) The passing of qualifying examinations in history of philosophy, metaphysics, value theory, and logic and epistemology.
(d) The completion of a written thesis on a subject approved by the department. At least one year of thesis research must be spent in residence.
(e) Satisfactory performance of limited teaching duties assigned by the department.
(f) The passing of a final oral examination, not limited to the student's special field of study.

COURSES

Philosophy 221a. Philosophical Classics (3-0-3).

Introduction to major figures in the Western philosophical tradition, centered around the mind-body problem. Readings in Plato, Descartes, Locke, Berkeley, Hume, Kant and Ryle. *Mr. Kolenda*

Philosophy 222b. The Imagination of the West (3-0-3).

Study of the forms of thought and feeling that have shaped the Western imagination, conducted by means of an examination of philosophical texts, poetry, music, film, and contemporary popular culture. Materials studies will vary from year to year, but a typical semester might include such things as a Platonic dialogue, St. Augustine's *Confessions,* the Goliad poets, Coleridge's *Biographia Literaria,* Rock'n'Roll music, and the Hippie Ethic. *Mr. Mackey*

Philosophy 271a. Introduction to Religious Thought, I (3-0-3).

Introduction to major questions in the philosophy of religion: the existence of God, the problem of evil, the nature of religious experience and its relation to doctrines, the relation of theology to science and to ethics. *Mr. Austin*

Philosophy 272b. Introduction to Religious Thought, II (3-0-3).

Study of various types of contemporary religious orientation, Protestant, Roman Catholic and Jewish. Special attention to existential questions of freedom, history and destiny. Readings in Kierkegaard, Nietzsche, Buber, Maritain, Bonhoeffer and Bultman. *Mr. Nielsen*

Philosophy 301a. Thales to Plotinus (3-0-3).

Extensive reading and discussion of major texts of ancient philosophy in translation. Not given in 1968. *Mr. Fulton*

Philosophy 302. Medieval Philosophy (3-0-3).

Historical and critical study of some major medieval thinkers, with emphasis on their metaphysical and epistemological views. Philosophers studied include St. Augustine, St. Anselm, Peter Abelard, St. Bernard of Clairvaux, St. Bonaventura, St. Thomas Aquinas, Duns Scotus, William Ockham. Offered in the fall semester of 1968-69. *Mr. Mackey*

Philosophy 303a. Galileo to Hume (3-0-3).

Historical and critical study of major works of seventeenth- and eighteenth-century rationalism and empiricism. *Mr. Fulton*

Philosophy 304b. Kant and the Nineteenth Century (3-0-3).

Study of major philosophical movements of European and American thought from the late eighteenth to early twentieth centuries. *Mr. Kolenda*

Philosophy 311a. History of Religion: The Far Eastern Tradition (3-0-3).

Reading in the holy books of India, China, and Japan. Study of Hinduism, Buddhism, Confucianism, Taoism, and Shinto. Critical biography of the founders and leading teachers of the major traditions. Examination of contemporary expressions of Eastern religions as "living faiths." *Mr. Nielsen*

Philosophy 312b. History of Religion: The Western Tradition (3-0-3).

Study of Judaism, Christianity, and Islam in their historical development. Attention to the basic themes of Western theism: God, immortality, history, evil, and redemption. Use of Biblical criticism in the study of the Old and New Testaments as well as the Koran. Prerequisite: Philosophy 311a or permission of instructor. *Mr. Nielsen*

Philosophy 321a. Logic (3-0-3).

A study of first-order logic with emphasis on proof-theoretic techniques; also an introduction to non-truth functional logics, higher-order logics, and the philosophy of logic. *Mr. Giannoni*

Philosophy 322b. Advanced Logic (3-0-3).

Consistency, completeness, and decidability of first-order and higher-order logics; Turing machines; recursive techniques and computability. *Mr. Giannoni*

Philosophy 323a. Philosophy of Science (3-0-3).

In what sense do scientific theories aim to "explain" nature? How are they related to philosophical and "common sense" ideas? How are they constructed and tested? Particular attention to the relations of causality, chance, and probabillty in physical theory, and to physical explanations of organic and mental phenomena. *Mr. Austin*

Philosophy 326b. Philosophy of Social Sciences (3-0-3).

The central issue is the specific character of social scientific explanation. Topics to be considered include: "action" vs. "behavior" explanations; operationalism, behavioralism, and experimentation vs. theory construction; the role of models; the role of statistics. *Mr. Giannoni*

Philosophy 331a. Ethics (3-0-3).

Study of some representative traditional and contemporary theories, and an examination of their bearing on practical issues. *Mr. Manser*

Philosophy 334b. Moral and Political Philosophy (3-0-3).

Examination of one or more of the following issues and topics: the concept of morality, the basis of political authority, justice, morality and law, the nature and extent of liberty, political and social theories. Some attention will be given to issues such as the legal punishment of immorality, the First Amendment, the death penalty. *Staff*

Philosophy 361a. Aesthetics (3-0-3).

Readings in ancient, medieval, and modern aesthetics, focused on problems in the metaphysics of art and beauty. Special attention will be given to the arts of language (rhetoric and poetry) by reading and discussion of selected writings in literary theory. *Mr. Mackey*

Philosophy 362b. Philosophy in Literature (3-0-3).

Study of philosophical themes in selected works in the English, French, German, and Russian literatures from Shakespeare to Beckett. *Mr. Kolenda*

Philosophy 401a. Independent Study (3-0-3).

Department permission required. *Staff*

Philosophy 402b. Independent Study (3-0-3).

Department permission required. *Staff*

Philosophy 404b. Contemporary Philosophy (3-0-3).

Bradley to Whitehead. *Mr. Fulton*

Philosophy 441a. Epistemology (3-0-3).

Examination of one or more of the following topics: the concepts of knowledge, belief, certainty, evidence, perception; theories of knowledge such as realism, phenomenalism, rationalism. Mainly twentieth century philosophers will be considered. *Staff*

Philosophy 462b. Existential Psychoanalysis (3-0-3).

The notion of existential psychoanalysis, especially as worked out in Sartre's *Saint Genet.* *Mr. Manser*

Philosophy 476b. Natural Science and Religion (3-0-3).

A brief history of the interaction of religious ideas and scientific theories since Copernicus and Luther, followed by a close examination of theories (in biology, cosmology, and metaphysics) which have been thought particularly relevant to religious and ethical questions. *Mr. Austin*

Philosophy 501a. Research and Thesis (3-0-3).

Staff

Philosophy 502b. Research and Thesis (3-0-3).

Staff

Philosophy 511a. Wittgenstein and His Influence (3-0-3).

Study of Wittgenstein's *Philosophical Investigations* and of its influence on contemporary philosophy. *Mr. Kolenda*

Philosophy 513a. Peirce and Pragmatism (3-0-3).

Study of the thought of C. S. Peirce and of its influence on other pragmatists, especially William James and John Dewey. *Mr. Kolenda*

Philosophy 521a. Readings in Non-Christian Religious Philosophy (3-0-3).

Critical examination of the major traditions of Indian and Chinese philosophy. Attention to both historical development and modern expressions of Hindu and Buddhist thought. Appraisal of contemporary interpretations as related to both idealism and existentialism. *Mr. Nielsen*

Philosophy 522b. Protestant Philosophy since the Reformation (3-0-3).

Critical appraisal of the relation of the Reformation to the philosophical tradition: Protestant scholasticism, nineteenth-century idealism and modern neo-orthodoxy. Readings in Luther, Calvin, Kant, Schleiermacher, Kierkegaard, Nietzsche, and Karl Barth. *Mr. Nielsen*

Philosophy 524a. Hellenism and Christianity (3-0-3).

Study of the Hebrew and Greek traditions as the principal determinants of Western theism. Treatment of Christian philosophy in relation to Biblical criticism, hermeneutics and the problem of demythologizing. Not offered in 1968-69. *Mr. Nielsen*

Philosophy 525b. The Problem of Religious Knowledge (3-0-3).

Consideration of the major types of religious epistemology in their contemporary expression. Readings in Dilthey, Heidegger, Jaspers, Ricoeur, Gadamer, and Ian Ramsey. Not offered in 1968-69. *Mr. Nielsen*

Philosophy 542b. Symbolism (3-0-3).

The theory of symbols and their use in philosophy, literature, religion, etc. Readings in Cassirer, Whitehead, medieval theorists, and others. *Mr. Mackey*

Philosophy 543a. Hegel (3-0-3).

Study of *Phenomenology of Mind* and *Encyclopaedic Logic,* with papers on special projects. Not offered in 1968-69. *Mr. Fulton*

Philosophy 544b. Metaphysics (3-0-3).

Systematic study of selected metaphysical problems, conducted by means of examination of classical and modern texts. Not offered in 1968-69. *Mr. Mackey*

Philosophy 545a. Kant (3-0-3).

Close study of the *Critique of Pure Reason.* Papers and projects of special problems in Kantian philosophy. *Mr. Fulton*

Philosophy 552b. Husserl (3-0-3).

Not offered in 1968-69. *Mr. Fulton*

Philosophy 554b. Whitehead (3-0-3).

Not offered in 1968-69. *Mr. Fulton*

Philosophy 556b. Philosophical Psychology (3-0-3).

Investigation of one or more of the following concepts: sensation, memory,

imagination, dreaming, thinking, action, willing, intention, pleasure, emotion, desiring, etc. Attention will be given to such traditional problems as: mind and body, action and will, free will and necessity, etc. *Staff*

Philosophy 567a. Philosophy of Mathematics (3-0-3).

Study of logicism, intuitionism, and formalism. Special attention will be given to the following topics: the existence of mathematical entities, relation of mathematics to logic and empirical science, the nature of mathematical and logical reasoning. *Mr. Giannoni*

Philosophy 573a. The Nature of Dialectic (3-0-3).

Study of Sartre's *Critique de la raison dialectique,* including a general discussion of the nature of dialectic in Hegel and Marx. *Mr. Manser*

Philosophy 575a. Analytic Philosophy (3-0-3).

Investigation of one or more than one topic in recent philosophy dealing with the following: the problem of other minds, knowledge and belief, the nature of analysis, description and reference, the analytic-empirical distinction, reasons and causes of action. *Staff*

Philosophy 576b. Explanation of Behavior (3-0-3).

Study and critical discussion of Charles Taylor's book bearing this title and of other related issues and theories. *Mr. Manser*

Philosophy 582b. Current Issues in the Philosophy of Science (3-0-3).

Recent literature on a small number of interrelated topics pertaining to the "logic" of scientific theories, will be considered in some detail. Prerequisite: previous work in philosophy of science, or permission of instructor. (Not given in 1968-69.) *Mr. Austin*

Philosophy 583a. Philosophy of Physics (3-0-3).

Study of the philosophical problems in physical geometry, Relativity Theory, and Quantum Theory. Topics to be discussed include: Riemann's philosophy of space; Non-Euclidean geometries; the concept of simultaneity; the role of indeterminism in Quantum Theory. (Not given in 1968-69.) *Mr. Giannoni*

Philosophy 584b. Science and Philosophy in the "Scientific Revolution" (3-0-3).

Major exponents and critics of the "corpuscular philosophy will be studied, with emphasis on the interaction among conceptions of scientific method, fundamental world-pictures, and mathematically formulated theories. Prerequisite: previous work in philosophy of science, or permission of instructor. *Mr. Austin*

Physical Education

(*See* pages 205-207)

Physics

Professors Class, Donoho, Estle, Houston, Phillips, Risser, Rorschach, *Chairman,* Trammell, and Walters
Visiting Professor Wildermuth
Associate Professors Clayton and Duck
Assistant Professors Baker, Jordan, and Lane
Lecturers Bryan and MacKellar

Undergraduate Program. The general requirements for the Bachelor of Arts with a major in physics are outlined on pages 56-57. Students expecting to major in physics should enroll in Physics 210a,b and 230a in the Sophomore year. Four physics lecture courses and two laboratory courses must be selected in the Junior and Senior year and will usually include:

Junior year:	Physics 310a,b and Physics 400a,b Laboratory (Physics 330b)
Senior year:	Physics 415a,b and Physics 425a,b Laboratory (Physics 430a,b)

Students with advanced standing or extraordinary ability may be permitted to register in one or more graduate courses in the Senior year. In addition, students with extraordinary ability and research interest may be permitted to begin experimental or theoretical research with faculty supervision during the summer between their Junior and Senior years. They may continue this work during their Senior year in lieu of the regular Senior laboratory sequence. Two mathematics courses should be selected in consultation with a member of the physics faculty. Each student will be assigned a faculty adviser at the end of his Sophomore year, who will be responsible for course registration for the Junior and Senior year. The adviser will also be responsible for engaging the student's participation in some aspect of his research program.

Chemical Physics Major. An interdepartmental major in chemical physics is offered in conjunction with the Department of Chemistry. Students wishing to elect this major must be approved by both departments.

Graduate Program. The Department of Physics offers studies and research programs leading to the degrees of Master of Arts and Doctor of Philosophy. The Physics Department offers research facilities and thesis supervision in the fields of Atomic Physics and Quantum Electronics, Nuclear Physics, Solid State and Low Temperature Physics and Theoretical Physics.

To be eligible for the Master of Arts degree, a graduate student must complete 30 semester hours of approved graduate-level studies, including a research thesis performed under the direction of a physics

faculty member. He must demonstrate proficiency in one foreign language. A minimum of one year of graduate study is required for the M.A. To be eligible for the Doctor of Philosophy degree, a graduate student must first satisfy the department of his ability to actively engage in advanced research. This is normally done by successfully completing the work for the Master of Arts in physics, or by equivalent research publication. The student must also complete 60 hours in residence of approved graduate-level studies, including a research thesis completed under the direction of a physics faculty member. He must demonstrate proficiency in one foreign language. A minimum of two years of graduate study is required for the Ph.D. Further details of research programs in physics and departmental degree requirements are contained in a pamphlet "Graduate Study in Physics and Space Science" available from the physics department on request.

COURSES

Physics 100a. Mechanics (3-0-3).

The first semester of the sequence in physics for those who will continue physics in the sophomore year. Topics of study include: kinematics; dynamics of particles and solids based on Newton's three laws of motion. The level of treatment is approximately that of the text "Mechanics and Heat" by Hugh D. Young. Students taking Physics 100a must have completed or be enrolled in Mathematics 100a or b or Mathematics 220a or b. *Messrs. Bryan and Rorschach*

Physics 100b. Introductory Relativity and Beginning Electricity and Magnetism (3-0-3).

The second semester of the sequence in physics for those students who will continue physics in the sophomore year. Topics included are introductory relativity and the initial part of electricity and magnetism which is continued in the sophomore year. The level of treatment is approximately that of the text "Electricity and Magnetism" by E. M. Purcell. Prerequisite: Physics 100a. Students enrolled in Physics 100b must enroll in Physics 130b. *Messrs. Bryan and Rorschach*

Physics 101a, b. Introductory Survey of Physics (3-3-4, each sem.).

An introductory course consisting of two lecture hours, one tutorial hour, and three hours of laboratory work per week. This course provides a broad study of classical and modern physics and evolution of contemporary attitudes in these fields. It is designed as a terminal course to be open only to academic students and students of architecture. Students taking Physics 101 must have completed or be enrolled in Mathematics 100a,b or Mathematics 101a,b. This course is especially recommended for academic students in their Junior or Senior year. It may also be taken by academic and architecture students at the Freshman and Sophomore level. Laboratory fee required. *Messrs. O'Brien and Soga*

Physics 130b. Elementary Physics Laboratory (0-3-1).

Required of all students who wish to receive credit toward graduation for Physics 100b. Elementary error analysis and curve fitting. Experiments on the classical motion of macroscopic bodies and electrons. Studies of the transient and steady state behavior of simple networks containing resistance, capacitance, and inductance. *Mr. Baker and Staff*

Physics 210a. Electricity and Magnetism (3-0-3).

The third semester of the four-semester sequence in physics for science and engineering students. The study of electricity and magnetism begun in Physics 100b is continued, with topics including electric currents, the fields of moving charges, electromagnetic induction, Maxwell's equations, and electric and magnetic

properties of matter. Students enrolled in Physics 210a must have completed Physics 100a,b and Mathematics 100a,b or 220a,b. They must be enrolled in a mathematics course of level 200 or higher. Students enrolled in Physics 210a must enroll in Physics 230a. *Messrs. Anderson and Walters*

Physics 210b. Wave Motion and Electromagnetic Waves (3-0-3).

The final semester of the four semester sequence in physics for science and engineering students. Topics include wave motion and oscillations, coupled oscillators, electromagnetic radiation, electromagnetic field energy and momentum, guided electromagnetic waves, and physical optics. Prerequisite: Physics 210a. *Messrs. Anderson and Walters*

Physics 230a. Elementary Physics Laboratory (0-3-1).

Required of all students who wish to receive credit toward graduation for Physics 210a. Transistor characteristics, transistor amplifier, negative and positive feedback, Klystron oscillator, microwave propagation, polarization, and diffraction. Elementary geometrical optics. Spectrum of atomic hydrogen. Photoelectric effect. *Mr. Baker and Staff*

Physics 310a, b. Introduction to Physics (3-0-3, each sem.).

This is the first year of a two-year sequence on modern physics. The historical need for quantum theory is reviewed. Wave mechanics is presented and applied to the one dimensional harmonic oscillator, to the free particle, and to the one-electron atom. Extensions of the theory to multi-electron atoms and to molecules are presented. The principal text for the course is on the level of "Fundamentals of Modern Physics" by R. M. Eisberg. Prerequisites: Physics 210a,b, completion of or simultaneous enrollment in Mathematics 300a,b or equivalent.

Physics 330a. Junior Physics Laboratory (0-3-1).

Fall Semester: Introduction to electronics. Basic properties of electron devices and their applications in physics research. Laboratory fee required. *Staff*

Physics 330b. Junior Physics Laboratory (0-3-1).

Required of all Juniors majoring in physics. Spring Semester: Introductory experiments in atomic and nuclear physics. Physics 310a,b must be taken concurrently. Laboratory fee required. *Mr. Jordan*

Physics 400a, b. Introduction to Mathematical Physics (4-0-4, each sem.).

A systematic review of the principal subjects in mechanics and electrodynamics. Mathematical methods, including differential equations and vector analysis, will be applied to the solution of problems in particle dynamics, vibrating systems, dynamics of rigid bodies, electrostatics, magnetostatics, and electromagnetic field. *Mr. Duck and Staff*

Physics 415a, b. Principles of Modern Physics (3-0-3, each sem.).

This course continues the development of the principles of modern physics begun in Physics 310. Topics in atomic, molecular, solid state and nuclear physics are covered. The course includes a treatment of the special theory of relativity, which gives the covariant formulation of the laws of mechanics and electrodynamics. *Mr. Wolf*

Physics 425a, b. Statistical and Thermal Physics (3-0-3, each sem.).

An introduction to the behavior of macroscopic systems and to the microscopic basis for that behavior. Topics include: The approach to equilibrium; statistical derivation of the laws of thermodynamics; classical thermodynamics of simple systems; methods and results of quantum and classical statistical mechanics; systems of interacting particles; magnetism; transport processes; kinetic theory; irreversible processes; and fluctuations. The principal text in the course is on the level of "Statistical and Thermal Physics" by F. Reif. *Mr. Köhler*

Physics 430a. Senior Physics Laboratory (0-3-1).

Required of all Seniors majoring in physics. Experiments in geometrical, physical, polarization, and quantum optics; spectroscopy, resonance fluorescence in atoms and nuclei; and microwave spectroscopy. Laboratory fee required. *Mr. Phillips*

Physics 430b. Senior Physics Laboratory (0-3-1).

Required of all Seniors majoring in physics. Experiments in physics of current research interest: low-energy nuclear spectroscopy; electron-positron annihilation; X-ray crystallography; electron paramagnetic resonance; the Meissner effect and other low-temperature phenomena; and optical pumping. Readings in the research literature are required. Laboratory fee required. *Mr. Phillips*

Physics 510a. Analytical Dynamics (3-0-3).

Lagrangian and Hamiltonian dynamics, normal vibrations, rigid body motion, and the transformation theory of dynamics. *Mr. Risser*

Physics 510b. Electromagnetic Theory (3-0-3).

Time-varying electromagnetic fields and boundary-value problems, radiation, and relativistic electrodynamics. *Mr. Risser*

Physics 520a, b. Principles of Quantum Mechanics (3-0-3, each sem.).

A deductive presentation of the principles of quantum mechanics with applications to various problems in spectroscopy, collisions of particles, emission and absorption of radiation, quantum statistical mechanics, motion of electrons in crystals, etc. As a prerequisite a student should have knowledge of elementary wave mechanics. *Mr. Houston*

Physics 540a, b. Nuclear Physics (3-0-3, each sem.).

Nuclear properties; interaction of radiation with matter and radiation detection; nuclear reactions and models of nuclear structure; nuclear forces; the fundamental particles and their interactions. *Mr. Class*

Physics 550a, b. Stellar Evolution and Nuclear Astrophysics (3-0-3, each sem.).

The physical principles governing the structure and evolution of stars and the synthesis of the elements in stellar interiors. The major topics are (1) state of matter at high temperature and density, (2) mechanisms of energy transport, (3) thermonuclear reaction rates, (4) calculation of stellar structure and evolution, and (5) the nucleosynthesis of the heavy elements. The experimental evidence from astronomy, nuclear physics, and natural abundances is correlated throughout. The emphasis of the course varies somewhat from year to year, but it may be ascertained in advance from the instructor. Previous or concurrent enrollment in Physics 520 is the only prerequisite. *Mr. Clayton*

Physics 560a, b. Structure of Solids (3-0-3, each sem.).

A review of the quantum mechanical theory of perfect crystals. Nuclear and electron motions will be studied as an explanation of thermal, electrical, and magnetic phenomena in solids. The theory of finite groups will be outlined and applied to crystal phenomena. Not offered every year. *Mr. Houston*

Physics 563. Introduction to the Solid-State (3-0-3).

This course will provide an introduction to the fundamental concepts about crystalline solids, and provide the basic preparation for further courses in the sequence Physics 564-567. It will consist of the following: a brief review of Quantum Mechanics and Statistical Mechanics, a discussion of crystal structure, a study of the diffraction of waves by lattices, and an introduction to the concept of the reciprocal lattice, classical and quantum-mechanical descriptions of lattice vibrations and the thermal properties of insulators, and the properties of electrons in solids including free-electron and band-theoretical approaches. Prerequisites: An introductory background in wave mechanics and statistical mechanics, and con-

current enrollment in a graduate level quantum mechanics course is assumed. Also offered as Chemistry 563, Electrical Engineering 563, and Mechanical Engineering 563. *Staff*

Physics 564. Electron Transport and Superconductivity (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow Physics 563. It will consider various aspects of electron transport, primarily from a microscopic viewpoint. Among topics to be covered will be various contributions to electron scattering and some techniques for measuring the Fermi Surface. In addition, an introduction to superconductivity will be presented. Prerequisite: Physics 563 or equivalent. Also offered as Chemistry 564, Electrical Engineering 564, and Mechanical Engineering 564. *Mr. Rudee*

Physics 565. Dielectric & Optical Properties of Matter (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow Physics 563. Topics included are: polarization and the static model of a dielectric medium in an electric field; extension of the above model to the dynamic case and dielectric dispersion in solids; stimulated effects with applications to lasers; the dynamics of nonlinear interaction between radiation and matter. Prerequisite: Physics 563, or equivalent. Also offered as Chemistry 565, Electrical Engineering 565, and Mechanical Engineering 565. *Mr. Rabson*

Physics 566. Imperfections and Mechanical Properties

This course is one of the introductory graduate level courses on the solid state that follow Physics 563. Point defects in crystals, geometrical description of dislocations and the mathematical theory of lattice imperfections will be discussed. Nonthermal generation of point defects, physical observation of defects in crystals and special properties of lattice imperfections in metallic, ionic and homopolar crystals will be covered. How lattice imperfections in ionic, metallic and homopolar crystals affect certain physical properties of these crystals will be developed. The effects of lattice defects, particularly dislocations, upon the mechanical properties of crystals will be discussed. Prerequisites: Physics 563 or equivalent. Also offered as Chemistry 566, Electrical Engineering 566, and Mechanical Engineering 566.
Messrs. Roberts and Estle

Physics 567. Magnetism and Magnetic Resonance (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follow Physics 563. The basis of the magnetic properties of solids will be discussed. This will include diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, and ferrimagnetism. The phenomenon of magnetic resonance will be studied. This will include nuclear magnetic resonance, electron paramagnetic resonance, and ferromagnetic resonance. The emphasis will be on the atomic origin of magnetism, and on a description of the elementary excitations of ordered magnetic materials. Prerequisite: Physics 563, or equivalent. Also offered as Chemistry 567, Electrical Engineering 567, and Mechanical Engineering 567. *Mr. Estle*

Physics 570a, b. Atomic Physics (3-0-3, each sem.).

Theory of atomic and molecular structure. Theory of atomic collisions and application to the study of basic atomic and molecular processes. *Mr. Lane*

Physics 590. Research Work.

Staff

Physics 600a, b. Special Topics in Solid-State Physics

Not offered every year. *Staff*

Physics 610a, b. Advanced Experimental Nuclear Physics

Topics of interest to the experimental nuclear physicist. Not offered every year. *Staff*

Physics 620a, b. Theoretical Nuclear Physics (3-0-3, each sem.).

General nuclear properties, two-body problems, scattering, nuclear spectroscopy,

nuclear reactions, interaction of nuclei with electromagnetic and electron-nuetrino fields, nuclear shell theory. Offered in alternate years. *Mr. Köhler*

Physics 630a, b. Advanced Quantum Mechanics (3-0-3, each sem.).

Many Body Theory: Hartree-Fock and Thomas-Fermi approximations, atomic and nuclear multiplets, Racah Algebra, second quantization, Feynman diagrams, Green's functions, quasi particles and collective motions, applications. Collision and Radiation Theory: Formal scattering theory, Lippman-Schwinger equation, analytic properties of the S-matrix, causality, optical theorem, dispersion relations. Applications: potential scattering, resonance reactions, direct reactions, coherent scattering from complex systems, optical model, quantum theory of radiation, Dirac equation, Feynman propagators and rules for computation of S-matrix, theory of renormalization, Dyson equation applications. *Mr. Trammell*

Physics 640. Special Topics in Nuclear Physics.

Current developments. In 1966-67, a survey of nuclear models. Not offered every year. *Staff*

Physics 660b. Gravitation and Relativity (3-0-3).

A study of the theories of gravitation with emphasis on the General Theory of Relativity. Applications, experimental tests, and cosmological implications are discussed. A familiarity with the Special Theory of Relativity such as is covered in Physics 415 or equivalent is desirable. Also given as Space Science 560b. *Mr. Michel*

Physics 700. Summer Graduate Research.

Open only to students already admitted as candidates for an advanced degree. At least forty hours of laboratory work per week. *Staff*

Political Science

Professors Tullock and von der Mehden
Associate Professors Ambler, Cooper, *Chairman,* and Dix
Assistant Professors Cuthbertson and Gerhardt
Lecturer Hudspeth
Instructor Hinckley

POLITICAL SCIENCE

Majors in Political Science. Students majoring in political science are required to take the equivalent of five two-semester courses in the field. These must include Political Science 210a,b in addition to courses selected from at least three of the following areas:

1. American Politics.
2. Comparative Government.
3. Constitutional Law.
4. International Relations.
5. Political Theory.

Six hours of advanced work, selected upon the advice of the department, should also be completed in any of the following fields: anthropology, economics, history, humanities, philosophy, sociology, or psychology.

COURSES

Political Science 210a, b. Introduction to Political Science and American Government (3-0-3, each sem.).

This course studies the nature of political science, the origin of the state, and major ideologies. An examination of British parliamentary democracy provides a background to American institutions. The course then examines the history and operation of the federal government and American politics. Planned for any student interested in political science, the course is also designed to meet state professional requirements for prospective lawyers, physicians, and teachers.
Mr. Cooper, Cuthbertson and others

Political Science 305a. Directed Reading I (0-0-3).

Independent reading under the supervision of a member of the department. Open only to Junior majors with the consent of the department. *Staff*

Political Science 306b. Directed Reading II (0-0-3).

Continuation of Political Science 305a. Independent reading under the supervision of a member of the department. Open only to Junior and Senior majors with the consent of the department. *Staff*

Political Science 310a, b. Law and Society (3-0-3, each sem.).

The study of law as a social science. Approximately one-third of the course deals with such concepts as the meaning of justice, the development of the English common law, equity, and statutory law, and their adoption in the United States; the meaning of jurisdiction and our state and federal court system. The remaining two-thirds of the course deals with the substantive law of contracts, agency, bailments, sales, partnerships, and corporations. The casebook method is employed for the latter part of the course. *Mr. Hudspeth*

Political Science 315a. American Government and Politics (3-0-3).

A study of American national policy-making, emphasizing the roles of Congress and the Presidency in the processes of legislation and administration and the interaction of these institutions with interest groups, political parties, the bureaucracy and the courts. *Mr. Gerhardt*

Political Science 316b. American Governmental Policies (3-0-3).

Application of a general analysis of American national policy-making to selected fields of governmental activity, including foreign aid, defense policy, and fiscal policy. Prerequisite: Political Science 315a. *Mr. Gerhardt*

Political Science 320a. American Constitutional Law (3-0-3).

This course deals with the interpretation of the Constitution by the Supreme Court. The treatment is largely historical and deals primarily with problems of federalism, the commerce clause, protection of property, taxation, the separation of powers, and civil rights. The casebook method is used, supplemented by assigned readings. Not offered in 1968-69. *Mr. Hudspeth and Mr. Cuthbertson*

Political Science 325a. Development of American Political Institutions (3-0-3).

This course will attempt to place three major subsystems in the American political system in historical perspective. Attention will be devoted to the development of the national party system, the Congress, and the Presidency in their contemporary forms, to their relations and interdependencies in various periods, and to the causes and determinants of change. In addition, some attention will be devoted to systems analysis as a theoretical construct for approaching the problem of institutional change and development. *Mr. Cooper*

Political Science 330b. American Parties, Politics, and Pressure Groups (3-0-3).

The nature and functions of contemporary American political parties and pres-

sure groups. The course will include a study of American elections and public opinion, party composition and organization, and the relation of parties and pressure groups to legislation and administration. *Miss Hinckley*

Political Science 340a. Ancient and Medieval Political Theory (3-0-3).

This course introduces the sources of ancient and medieval political thought. Special emphasis will be given to the historical analysis of political philosophy and mythology and to the influence of Plato and Aristotle. *Mr. Cuthbertson*

Political Science 341b. Modern Political Theory (3-0-3).

This course examines the problems and concepts of contemporary political theory: democracy and totalitarianism; state and individual; power and scientific politics; liberalism and conservatism; "the lunatic fringe"; and the "decline" of modern political thought. It compares the theoretical origins of modern governments and studies the theory of nationalism. *Mr. Cuthbertson*

Political Science 360a. Comparative Government: Western European Democracies (3-0-3).

A survey of government and politics in Western European democracies, with primary emphasis on Great Britain, France, and Germany. *Mr. Ambler*

Political Science 361b. Comparative Goverment: Totalitarian Systems and the Politics of Modernization (3-0-3).

The first half of the semester will be devoted to a study of totalitarian political systems, notably Nazi Germany, the U.S.S.R., and Communist China. The last half of the course will deal with selected political systems in underdeveloped areas, focusing upon problems of political modernization. *Mr. Ambler*

Political Science 370a. International Relations (3-0-3).

An analysis of basic factors in world politics and examination of various systems of international relations—from the balance of power to nuclear multipolarity. The course will also deal with the changing nature of world politics by analysing new factors and forces in international relations and the new meaning of war and peace in a greatly enlarged international community of the mid-twentieth century. *Mr. Tullock*

Political Science 380a. Introduction to Political Behavior (3-0-3).

An examination of the behavioral approach to the study of politics. Topics to be discussed will include voting behavior, community power, legislative behavior, political culture and the significance for democratic government of findings in these areas. *Miss Hinckley*

Political Science 405a, b. Senior Thesis (0-0-6).

Open only to Senior majors upon invitation by the department. Students must complete both Political Science 405a and 405b in order to obtain credit. *Staff*

Political Science 415a. Seminar in American National Security Policy (3-0-3).

Reading and research on selected topics related to the goals, decision processes, conduct, and impact of American national security policies. Prerequisite: consent of the instructor. *Mr. Gerhardt*

Political Science 440a. Collective Decision-Making (3-0-3).

An introduction to the use of abstract logical models in political analysis. The existing models, closely resembling those used in economics, will be explored in detail and their application to the real world examined. Although the course will mainly deal with the simpler political models, the newer and more complicated applications of this method will also be discussed. *Mr. Tullock*

Political Science 455b. Government and Politics in Great Britain (3-0-3).

This seminar will deal with British political institutions, political parties, political culture, and other selected topics. Prerequisite: Political Science 360a or consent of the instructor. Not offered in 1968-69. *Mr. Ambler*

Political Science 460b. Comparative Politics (3-0-3).

With a primary focus on informal political processes, this course deals with selected topics such as political culture, social structure and politics, oligarchy and democracy, political parties, electoral systems, pressure groups, civil-military relations, and political change. These and other topics will be examined in a comparative context with material to be drawn primarily from Western democracies and from underdeveloped areas. Prerequisite: consent of instructor. *Mr. Ambler*

Political Science 465a. Government and Politics in France (3-0-3).

This seminar will deal with French political institutions, political parties, political culture, and other selected topics. Prerequisite: consent of instructor. *Mr. Ambler*

Political Science 485b. Seminar in Political Behavior (3-0-3).

Advanced readings and research on special topics in political behavior. Prerequisite: Political Science 380a. *Miss Hinckley*

Political Science 490a, b. Research Seminar in Modern Political Theory and Interdisciplinary Fields (3-0-3, each sem.).

Open only to qualified Seniors after consultation with the instructor. *Mr. Cuthbertson*

Portuguese

(*See* pages 137-140)

Psychology

(*See* pages 124-126)

Russian

(*See* pages 137-141)

Sociology

(*See* pages 120-124)

Space Science

Professors Dessler, *Chairman,* Gordon, Low, O'Brien, Stebbings, and Walters
Associate Professors Clayton, Freeman, Haymes, Heymann, and Michel
Assistant Professors Anderson, Cloutier, Goldwire, Soga, Tucker, and Wolf

Research opportunities exist for graduate studies leading to degrees of Master of Science and Doctor of Philosophy in the Department of Space Science. To gain such a degree a student must be knowledgeable in many areas of space science and expert in at least one.

There is no bachelor's degree with a major in Space Science. However, elective courses are offered to acquaint Rice undergraduates and graduates from other institutions with many of the concepts and research opportunities in space science.

Space science is an interdisciplinary field; undergraduates with bachelors' degrees in astronomy, chemistry, electrical engineering, geophysics, physics, or any of several other scientific and engineering disciplines may apply for admission to graduate work in the department. The Department of Space Science research programs include astrophysics, fields and particles, meteoritics, planetary structure and planetary atmospheres.

GRADUATE PROGRAM

The requirements for M.S. and Ph.D. degrees are outlined below. A booklet giving more detailed and specific information is available from the department office.

Degree of Master of Science. A candidate for a master's degree shall have completed successfully at least 30 semester hours of approved graduate-level studies. He must also demonstrate his understanding of Space Science in an oral examination by his faculty committee. He shall prepare a written thesis on an original research topic and defend his thesis orally.

Degree of Doctor of Philosophy. The basic requirement for a student to receive the Ph.D. is that he demonstrate the capacity for independent, original research. In addition, there are the following formal requirements:

A student is normally admitted to candidacy for the Ph.D. by satisfying the requirements for the M.S. degree in space science.

A minimum of three years' graduate study is normally required. Candidates who hold a master's degree may complete requirements for the doctorate in two years. The student must complete at least 60 hours in residence of approved graduate-level studies, in addition to demonstrating proficiency in one foreign language. A candidate shall

prepare a thesis on an original research topic and defend the thesis orally. The thesis must be of such quality that it would be acceptable for publication in a reputable scientific journal.

COURSES

Space Science 300b. General Astronomy (3-0-3).

An introduction to the changing realm of astronomy. This course will be essentially descriptive in nature. It will cover such topics as astronomical instruments, the solar system, stars, galaxies, quasars, etc. Cosmological theories concerning the origin and evolution of the universe will also be discussed. No prerequisites; open to Sophomores with permission. *Messrs. Kovar and Rosenberg*

Space Science 400a, b. Introduction to Space Science (3-0-3, each sem.).

An introduction to phenomena of current interest in space science, including: astronomy, astrophysics, solar-terrestrial relationships, properties of the interplanetary medium, cosmic radiation, the Van Allen and other radiation belts, auroras, and planetary atmospheres and ionospheres. Emphasis will be on qualitative descriptions rather than rigorous analyses. Prerequisite: Physics 100 and 200 or equivalent. *Messrs. Cloutier and Haymes*

Space Science 500a, b. Particles and Fields (3-0-3, each sem.).

An introduction to the interactions on a cosmic scale between charged particles and magnetic and electric fields. Topics include principles of plasma physics, particle orbit theory, the solar wind, the effect of the solar wind on magnetic fields of the earth and sun, geomagnetic storms, cosmic radiation, and Van Allen radiation. The first semester will be devoted to a rigorous treatment of the behavior of the plasma state. Research applications of basic principles will be covered in the second semester. *Messrs. Dessler and Tucker*

Space Science 510a. Analytical Dynamics (3-0-3).

Lagrangian and Hamiltonian dynamics, normal vibrations, rigid body motion, and the transformation theory of dynamics. Also offered as Physics 510a.

Space Science 510b. Electromagnetic Theory (3-0-3).

Time-varying electromagnetic fields and boundary-value problems, radiation, and relativistic electrodynamics. Also offered as Physics 510b.

Space Science 512b. Planetary Atmospheres (3-0-3).

A study of observed phenomena and processes in planetary atmospheres, both neutral and ionized. Properties of the earth's atmosphere will be studied in detail, and this information applied to an analysis of observations of atmospheres of other planets, with emphasis on Venus, Mars, and Jupiter. Space Science 400a,b or equivalent is prerequisite. *Messrs. Brown and Gordon*

Space Science 520a, b. Principles of Quantum Mechanics (3-0-3, each sem.).

A deductive presentation of the principles of quantum mechanics with applications to various problems in spectroscopy, collisions of particles, emission and absorption of radiation, quantum statistical mechanics, motion of electrons in crystals, etc. As a prerequisite a student should have a working knowledge of elementary wave mechanics. Also offered as Physics 520a,b.

Space Science 550a, b. Stellar Evolution and Nucleosynthesis (3-0-3, each sem.).

Analysis of the physical principles governing the structure and evolution of stars and the synthesis of elements in stellar interiors. Basic topics covered are (1) introduction to stars, (2) equation of state of ionized matter, (3) energy transport, (4) thermonuclear reaction rates, (5) calculation of stellar structure and evolution,

and (6) correlation of observed abundances with mechanisms of nucleosynthesis. The course is mathematical, but the physical motivations for all discussions will be emphasized. Previous or concurrent enrollment in Physics 520a,b is prerequisite. Also offered as Physics 550a,b. *Mr. Clayton*

Space Science 580. Graduate Research. Credit to be arranged.

Staff

Space Science 590a, b. Space Science Colloquium (1-0-1, each sem.)

Staff

Space Science 600a, b. Special Topics in Space Science (3-0-3, each sem.).

Current topics including modern developments in Space Science such as infrared astronomy, x-ray astronomy, lunar geology, auroral physics, etc. The emphasis may vary from year to year. *Staff*

Space Science 650a. Advanced Topics in Stellar Evolution (3-0-3).

The topics vary at the discretion of the instructor but may include: (1) computer programs in stellar evolution, (2) supernovae, (3) astrophysical sites of heavy-element synthesis, (4) nuclear chronology of the galaxy, (5) stellar pulsation, (6) stellar rotation, and (7) semiempirical approach to stellar evolution. Grades will normally be assigned on the basis of a written research paper. Space Science 550a,b is prerequisite. *Mr. Clayton*

Space Science 660b. Gravitation and Relativity (3-0-3).

A study of the theories of gravitation with emphasis on the General Theory of Relativity. Applications, experimental tests, and cosmological implications are discussed. A familiarity with the Special Theory of Relativity such as is covered in Physics 415 or equivalent is desirable. Also offered as Physics 660b. *Mr. Michel*

Space Science 700. Summer Graduate Research.

Open only to students already admitted as candidates for an advanced degree. At least forty hours of laboratory work per week. *Staff*

Spanish

(*See* pages 138-143)

Theater

(*See* pages 189-190)

Index

Academic Calendar, v
Academic curricula, 54
Academic honors and awards, 88
Academic regulations, 66
Academic Suspension, 68
Accounting, Fifth Year in, 56
Accounts, delinquent, 78
Administration, Officers of, 3
Admission, 71
  Early Decision Plan, 73
  Freshmen, 71
  Graduate, 102
  Regular Decision Plan, 73
  Transfer, 75
Advanced Degree Requirements, 99
Advanced Placement, 75
Anthropology, 120
  Courses, 120
  Curriculum, 53, 54
  Undergraduate Major, 120
Apprenticeship Plan for Student Teachers, 154
Approval of candidacy, graduate, 101
Approval of Majors, Undergraduate, 67
Architecture, 114
  Courses, 116
  Curriculum, 59
  Graduate study, 116
  Undergraduate requirements, 114
Architecture, William Ward Watkin Chair in, 48
Army Reserve Officers' Training Corps, 63
Art, courses, 189
Art History, courses, 189
Assistantship-Fellowship, Graduate, 105
Associates, Rice University, 5
Athletic Department Staff, 36
Athletics, 96
Automobiles, regulations on, 96
Awards, Prizes and, 89

Bartlett Aesthetics Program, 49
Behavioral Science courses, 118
Biblical Studies, Isla and Percy Turner Professorship in, 48
Bio-Chemistry
  Curriculum, 53, 56
  Major in, 127
Biology, 127
  Courses, 128
  Curriculum, 53-59
  Graduate study, 127
  Undergraduate requirements, 127
Board and room, 79
Board of Governors, 4
Bond, guaranty, 78
Brown and Root Chair of Engineering, 47
Business Administration, 144
  Courses, 150
  Curriculum, 53, 54

Calder, Louis, Professorship in Chemical Engineering, 47
Calendar, Academic, v
Campus and Facilities, 45
Chairs, 47
  American History, 47
  Architecture, 48
  Biblical Studies, 48
  Chemical Engineering, 47
  Chemistry, 49

Economics, 47
Engineering, 47
English, 48
Ethics, 48
Geology, 49
History, 47, 48
Management, 47
Mathematics, 47
Philosophy and Religious Thought, 48
Political Science, 48
Sociology, 48
Chapel, Memorial, 95
Change of Curriculum, 67
Charges, special, 77
Chemical Engineering, 157
Courses, 158
Curricula, 57-59
Graduate study, 158
Undergraduate program, 157
Chemical Engineering, Louis Calder Professorship in, 47
Chemical Physics
Curriculum, 53, 56
Major in, 133
Chemistry, 133
Courses, 134
Curriculum, 53-59
Graduate study, 133
Undergraduate program, 133
Chemistry, Robert A. Welch Chair in, 49
Civil Engineering, 161
Courses, 163
Curriculum, 57
Graduate study, 162
Classics, courses, 137, 139
College Board Tests, 71
College Masters, 9
Colleges, Residential, 45, 76, 79, 92
Commerce, 143
Courses, 143
Curriculum, 60
Committees, University standing, 38
Contents, iii
Course credit, 113
Course deficiencies, removal of, 69
Course numbers, 113
Courses of Instruction, 113-242
Courses of study, 54
Course programs, undergraduate, 54, 66
Curricula changes, 67
Curricula and Degrees, 53

Deficiencies, removal of course, 69
Degrees, 53, 99
Graduate, 99-103
Research, 100, 103
Undergraduate, 53
With honors, 70, 88
Delinquent accounts, 78
Delta Phi Alpha, 88
Doctor of Philosophy degrees, 99
Dormitories, see Residential Colleges, 45, 76, 79, 92

Early Decision Admission, 73
Economics, 144
Courses, 146
Curriculum, 53, 54
Graduate study, 144
Undergraduate program, 144
Economics, Henry S. Fox, Sr. Chair of Instruction in, 48
Economics, Reginald Henry Hargrove Chair in, 47
Education, 151
Courses, 153
Teacher's certificate, 151
Electrical Engineering, 168
Courses, 169

Curriculum, 57
Graduate study, 168
Undergraduate program, 168
Emeritus Faculty, 10
Employment, 87
Engineering, 155
See also, chemical, civil, electrical, and mechanical engineering
Engineering, Brown and Root Chair of, 47
Engineering, Professional Degrees in, 100, 102
English, 184
Courses, 185
Curriculum, 53, 54
Graduate study, 184
Undergraduate program, 184
English, Libbie Shearn Moody Professorship in, 48
Enrollment, Number, 43
Entrance examinations, 71
Entrance requirements, 71
Undergraduate, 71
Graduate, 102
Environmental Science and Engineering, 174
Courses, 175
Ethics, David Rice Chair in, 48
Examinations, graduate, 101
Examinations, undergraduate courses, 67
Expenses, Undergraduate, 77
Fees, 77
Living, 79
Special charges, 77
Tuition, 77
Expenses, Graduate, 104
Fees, 104
Tuition, 104

Faculty, 10
Faculty, Emeritus, 10
Fees, undergraduate, 77
Fees, graduate, 104
Fees, refund of, 78
Fellowship, Graduate, 105
Financial Assistance for New Students, 74
Fine Arts, courses, 189
Foreign Languages
See, Classics, French, German, Greek, Italian, Latin, Portuguese, Russian, Spanish
Fox, Henry S., Sr. Chair of Instruction in Economics, 48
Fox, Lena Gohlman, Chair of Instruction in Sociology, 48
French, 191
Courses, 192
Curriculum, 53, 54
Graduate study, 191
Undergraduate program, 191

General Information, 99
Geology, 195
Courses, 197
Curriculum, 53-59
Graduate study, 196
Undergraduate program, 195
Geology, Harry Carothers Wiess Chair in, 49
Germanics, 201
Courses, 202
Curriculum, 53, 54
Graduate study, 201
Undergraduate program, 201
Governors, Board of, 4
Grade symbols, 67
Graduate admission, 102
Graduate, Approval of Candidacy, 101
Graduate assistantships, 105
Graduate Council, 101
Graduate degrees, 99-103
Graduate fees, 104

Graduate fellowships, 105
Graduate areas of study, 99
Graduate language requirements, 101
Graduate living expenses, 104
Graduate oral examinations, 101
Graduate scholarships, 105
Graduate thesis regulations and procedure, 102
Graduation, 70
Grants, 80
Greek courses, 138
Guaranty bond, 78

Hargrove, Reginald Henry, Chair of Economics, 47
Health and Physical Education, 205
  Courses, 205
  Curriculum, 61
Health Service, 94, 109
Health service staff, 35
High school record, 71
Historical sketch of the University, 43
History, 208
  Courses, 209
  Curriculum, 53, 54
  Graduate study, 208
  Undergraduate program, 208
History, American, William Pettus Hobby Chair in, 47
History, Mary Gibbs Jones Professorship in, 47
History, Harris Masterson, Jr. Chair in, 48
History of Art, courses, 189
Hobby, William Pettus, Chair in American History, 47
Honors, 70, 88
Honor Council, 91
Honor Societies, 88
Honor System, 91, 108
Honor Roll, President's, 68
Honors and Prizes, Graduate, 108
Honors Programs, 53
Housing, graduate students, 109
Housing, undergraduate, 76
Humanities, 215
  Courses, 215
  Curriculum, in Division of, 54

Instructional staff, 10
Interviews, 72
Internship Plan for Student Teachers, 154
Italian, courses, 140

Jones, Jesse H., Professorship in Management, 47
Jones, Mary Gibbs, Professorship in History, 47

Language requirements, graduate, 101
Languages, foreign
  See, Classics, French, German, Greek, Italian, Latin, Portuguese, Russian, and Spanish
Latin, courses, 138
Lectures, Rockwell, 49
Lectures, Rice University, 49
Lectureships, 47
Library, 45, 46
Library Professional staff, 34
Linguistics, 216
Literary societies, 93
Living expenses, 79
Loans, 86, 87
Lovett, Edgar Odell, Professorship in Mathematics, 47
Majors, approval of, 67

Management, Jesse H. Jones Professorship in, 47
Martel, Mrs. Mamie Twyman, Chairs of Instruction, 48
Marine Corps, N.R.O.T.C., 64
Masters of residential colleges, 9
Master's Degrees, 99, 104
Masterson, Harris, Jr. Chair in History, 48
Mathematical Sciences, 223
Mathematics, 216
  Courses, 219
  Curriculum, 56, 57
  Graduate study, 216
  Undergraduate requirements, 216
Mathematics, Edgar Odell Lovett Professorship in, 47
Mathematics, W. L. Moody, Jr., Professorship in, 48
Mechanical Engineering, 175
  Courses, 176
  Curriculum, 57
Memorial Center facilities, 95
Military Science, 63
  Courses, 225
Moody, Libbie Shearn Professorship of English, 48
Moody, W. L., Jr. Professorship of Mathematics, 48
Music, courses, 226
Music, Shepherd School of, 49

Naval Science, 64
  Courses, 226
New Students, admission of, 71

Officers of Administration, 3
Oral examinations, graduate, 101
Organizations, student, 93

Parking, 96
Phi Beta Kappa, 88
Phi Lambda Upsilon, 88
Philosophy, 228
  Courses, 228
  Curriculum, 53, 54
  Graduate study, 228
  Undergraduate program, 228
Philosophy and Religious Thought, J. Newton Rayzor Chair in, 48
Physical Education
  See, Health and Physical Education, 205
Physics, 233
  Courses, 234
  Curriculum, 57
  Graduate study, 233
Pi Delta Phi, 88
Political Science, 238
  Courses, 239
  Curriculum, 53, 54
  Major in, 238
Political Science, Albert Thomas Chair of, 48
Portuguese, 140
President's Honor Roll, 68
Prizes and Awards, 89
Prizes, Graduate honors and, 108
Probation, 68
Probation, Special, 69
Professional Degrees in Engineering, Requirements for, 100, 102
Professional Research Staff, 31
Professional Staff of the Library, 34
Programs, undergraduate, 54, 66
Psychology, 124
  Courses, 124
  Curriculum, 53, 54

Rayzor, J. Newton, Chair in Philosophy and Religious Thought, 48

Readmission, 69
Refund of fees and tuition, 78
Registration, 66
Religious Thought, J. Newton Rayzor Chair in, 48
Removal of course deficiencies, 69
Requirements for Research Degrees, 100, 103
Research Computation Laboratory Staff, 36
Research Staff, Professional, 31
Reserve Officers' Training Corps, 63
Residential Colleges, 45, 76, 79, 92
Responsibility, Student, 91
Rice, David, Chair in Ethics, 48
Rice Television Series, 50
Rice University Associates, 5
Rice University Lectures, 49
Rice University Research Sponsors, 8
Rice University Standing Committees, 38
Rockwell Lectures, 49
Russian, courses, 140, 141

Science, curricula, 56
Scholarships, 80
Scholarships, graduate, 105
Scholarships, Tuition, 80, 107
Shepherd School of Music, 49
Sigma Delta Pi, 88
Sigma Tau, 89
Sigma Xi, 88
Societies, Honor, 88
Sociology, courses, 120
Sociology, Lena Gohlman Fox Chair of Instruction in, 48
Spanish, courses, 141
Space Science, 242
  Courses, 243
  Graduate Study, 242
Special charges, 77
Special Probation, 69
Staff, Athletic Department, 36
Staff, Health Service, 36
Staff, Instructional and Research, 10
Staff, Library, 34
Staff, Professional Research, 36
Staff, Research Computation Laboratory, 36
Student activities, 93
Student Association, 93
Student Association Service Award, 94
Student Center, 95
Student Employment, 87
Student Government, 93
Student Health Service, 94, 109
Student Housing, 76, 109
Student Life, 91, 108
Student Loans, 86, 87
Student Organizations, 93
Student Responsibility, 91
Student Senate, 93
Student Teaching Internship
  Fees, 78
  Plan, 154
Suspension, Academic, 68

Tau Beta Pi, 88
Tau Sigma Delta, 89
Teacher's certificate, 54, 151
Television series, 50
Ten Year Plan, 43
Theater course, 190
Thesis regulation and procedure, 102
Thomas, Albert, Chair of Political Science, 48
Transcripts, 78
Transfer students, admission of, 75

Trustees, 4
Tuition, undergraduate, 77
Tuition, graduate, 104
Tuition refund, 78
Tuition Scholarships, 80, 107
Turner, Isla and Percy, Professorship in Biblical Studies, 48

Undergraduate admission, 71
Undergraduate Approval of Majors, 67
Undergraduate courses of study, 54
Undergraduate fees, 77
Undergraduate grants, 80
Undergraduate living expenses, 79
Undergraduate programs, 54, 66
Undergraduate scholarships, 80
University Associates, 5
University campus and facilities, 45
University, historical sketch of, 43
University standing committees, 38

Voluntary withdrawal, 69

Watkin, William Ward, Chair in Architecture, 48
Welch, Robert A., Chair in Chemistry, 49
Wiess, Harry Carothers, Chair of Geology, 49
Withdrawal, voluntary, 69