Rice University

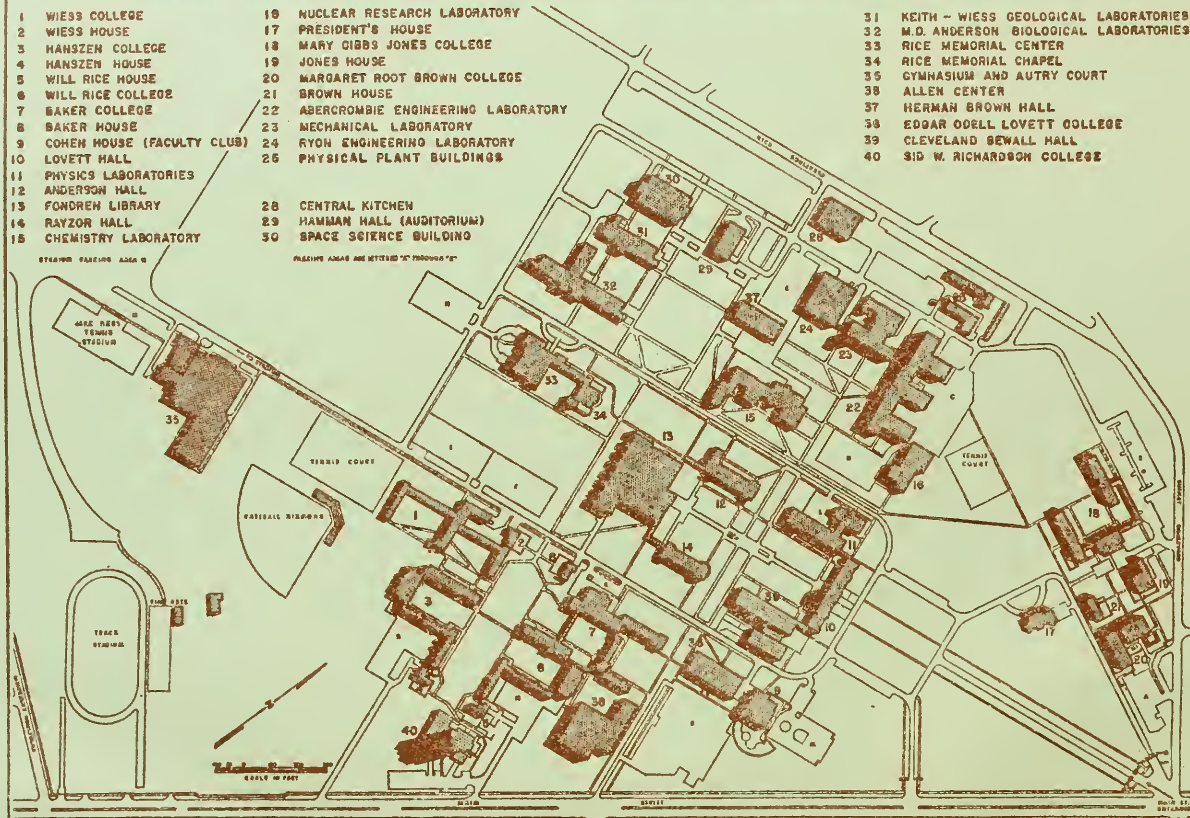
GENERAL ANNOUNCEMENTS

for the

Academic Year 1971-1972

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
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 EDGAR ODELL LOVETT COLLEGE
39 CLEVELAND SEWALL HALL
40 SID W. RICHARDSON COLLEGE



William Marsh Rice University

GENERAL ANNOUNCEMENTS

for the

Academic Year 1971-72

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
1971

Contents

1971

JULY

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DECEMBER

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1972

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JULY

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AUGUST

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SEPTEMBER

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OCTOBER

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NOVEMBER

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DECEMBER

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ACADEMIC CALENDAR
1971-72

First Semester

Monday, August 16	Last Day for Payment of Fees, Except for New Students
Monday, August 23	Arrival of Freshmen
Tuesday, August 24-Saturday, August 28, Incl.	Freshman Week
Sunday, August 29	Arrival of Remaining Students
Monday, August 30	Opening of Courses, 8:00 A.M.
Monday, September 6	Labor Day Holiday
Saturday, September 11	Deadline for Adding Courses to Schedule, 12:00 NOON
Saturday, October 2	Deadline for Removal of Incomplete Grades, 12:00 NOON
Monday & Tuesday, October 11-12	Mid-term Recess
Saturday, November 6	Deadline for Dropping Courses from Schedule, 12:00 NOON
Wednesday, November 24	Beginning of Thanksgiving Recess, 6:00 P.M.
Monday, November 29	Resumption of Courses, 8:00 A.M.
Thursday, December 9	Last Day of Classes
Wednesday, December 15	Beginning of Scheduled Examinations

Second Semester

Monday, January 10	Opening of Courses, 8:00 A.M.
Saturday, January 22	Deadline for Adding Courses to Schedule, 12:00 NOON
Wednesday, February 2	Major's Day
Saturday, February 12	Deadline for Removal of Incomplete Grades, 12:00 NOON
Saturday, February 19	Beginning of Mid-term Recess, 12:00 NOON
Monday, February 28	Resumption of Courses, 8:00 A.M.
Saturday, March 25	Deadline for Dropping Courses from Schedule, 12:00 NOON
Thursday, March 30	Beginning of Easter Recess, 6:00 P.M.
Tuesday, April 4	Resumption of Courses, 8:00 A.M.
Friday, April 28	Last Day of Classes
Wednesday, May 3	Beginning of Examinations
Friday, May 19	Baccalaureate Exercises
Saturday, May 20	Fifty-Ninth Commencement

Summer, 1972

June-July	Teaching Apprentice Session

Part One

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The Rice University Associates

The Rice University Research Sponsors

The College Masters

The Instructional and Research Staff

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Dean of Undergraduate Affairs

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CHARLES FRANK MOSER, B.A.
Assistant to the President for Development

HENRY RUSSELL PITMAN, B.A.
Assistant to the President

Administrative Staff

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LARRY A. BLACKWELL. *Assistant to the Dean of Science and Engineering and Campus Safety Officer*

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HARDY M. BOURLAND. *Laboratory Supervisor, Biomedical Engineering*

BONNIE C. HELLUMS. *Assistant to the Dean of Students*

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Professor of Biology

BROWN COLLEGE
Donald R. Baker, B.S., Ph.D. *Associate Professor of Geology*

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

JONES COLLEGE
Neil Havens, B.A., M.A. *Associate Professor of Drama*

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

RICHARDSON COLLEGE
J. Venn Leeds, Jr., B.A., B.S., M.S., Ph.D. *Professor of Electrical and Environmental Engineering*

WIESS COLLEGE
Mervyn Lea Rudee, B.S., M.S., Ph.D. *Associate Professor of Materials Science*

WILL RICE COLLEGE
James A. Castañeda, B.A., M.A., Ph.D. *Professor of Spanish*

The Instructional and Research Staff*

Emeritus Faculty

BATTISTA, JOSEPH LLOYD. *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

BRAY, HUBERT EVELYN. *Professor Emeritus of Mathematics and Faculty Associate Emeritus of Jones College*
B.A. (Tufts) 1910; M.A. (Harvard) 1916; Ph.D. (Rice) 1918

CRONEIS, CAREY. *Wiess Professor Emeritus of Geology and Chancellor Emeritus*
B.S. (Denison) 1922; M.S. (Kansas) 1923; Ph.D. (Harvard) 1928; LL.D. (Lawrence) 1944; D.Sc. (Denison) 1945; D.Sc. (Ripon) 1945; D.Eng. (Colorado Mines) 1949; LL.D. (Beloit) 1954; L.H.D. (Tampa) 1964; D.Sc. (Texas Christian) 1965; D.Sc. (Texas Tech.) 1967; D.Sc. (Beloit) 1968

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

GALLEGLY, JOSEPH S. *Professor Emeritus of English*
B.A. (Rice) 1925; M.A. (Rice) 1926

HALL, ARTHUR E. *Professor Emeritus of Music*
Mus. Bac. (Yale) 1924; M.M. (Baylor) 1949

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

HODGES, LEE. *Professor Emeritus of French*
B.S. (Harvard) 1930; M.A. (Rice) 1934

MCKILLOP, ALAN DUGALD. *Professor Emeritus of English and Faculty Associate Emeritus of Jones College*
A.B. (Harvard) 1913; A.M. (Harvard) 1914; Ph.D. (Harvard) 1920

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

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

* The Faculty is listed as of July 1, 1971.

SHELTON, FRED VERNON. *Professor Emeritus of French and Honorary Charter Associate of Hanszen College*
B.A. (Rice) 1926; M.A. (Rice) 1928; M.A. (Mexico) 1942; Docteur de l'Universitie (Paris) 1963

SIMONS, VERNE FRANKLIN. *Professor Emeritus of Accounting*
A.B. (Kansas) 1923; A.M. (Kansas) 1925

WILLIAMS, GEORGE GUION. *Professor Emeritus of English*
B.A. (Rice) 1923; M.A. (Rice) 1925

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

Faculty

ADAMS, D. R. *Instructor of Mathematics*
B.S. (South Dakota State) 1963; Ph.D. (Minnesota) 1969

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

AGUIRRE, ANGEL MANUEL. *Assistant Professor of Spanish and Italian*
B.A. (Universidad de Puerto Rico) 1961; M.A. (Stanford) 1963; Ph.D. (Stanford) 1968

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

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

AMBLER, JOHN S. *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. *Associate Professor of Space Science*
B.A. (Iowa) 1954; M.A. (Iowa) 1958; Ph.D. (California Inst. of Tech.) 1961

ANDERSON, ROGER B. *Assistant Professor of Russian and Nonresident Associate of Richardson College*
B.A. (Michigan) 1961; M.A. (Michigan) 1964; Ph.D. (Michigan) 1965

ANGENE, LYLE E. *Visiting Assistant Professor of Philosophy*
B.A. (Ohio State) 1964; M.A. (Ohio State) 1964; Ph.D. (Chicago) 1970

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

ANTUNES, GEORGE. *Instructor of Political Science*
A.B. (Gonzaga) 1966; M.A. (Northwestern) 1969

ARMENIADES, CONSTANTINE D. *Assistant Professor of Chemical Engineering*
B.S. (Northeastern) 1961; M.S. (Case) 1967

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*
B.A. (Wesleyan) 1957; B.D. (Yale) 1960; Ph.D. (Yale) 1966

AVÉ LALLEMANT, HANS GERHARD. *Assistant Professor of Geology*
B.Sc. (Leiden) 1960; M.Sc. (Leiden) 1964; Ph.D. (Leiden) 1967

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, MINO D. *Associate Professor in Fine Arts*
B.A. (City College of New York) 1959; M.A. (Columbia) 1963; Ph.D. (Columbia) 1968

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

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

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B.A. (Rice) 1964

BOOTHE, JOE R. *Manager of Administrative Systems*
B.S. (Trinity University) 1959

CAVANAUGH, ROBIN. *Scientific Programmer*
B.S. (Kansas State) 1967

CHISM, SUSAN K. *Programmer/Analyst*
B.A. (Vanderbilt) 1968

FIELDS, CORINNE V. *Programmer/Analyst*
B.B.A. (S.M.U.) 1950

FRANCOIS, MICHAEL D. *Systems Programmer*
B.S. (Southwest Louisiana) 1966; M.S. (Southwest Louisiana) 1968

FROSCH, ALEX. *Senior Scientific Programmer*
B.A. (Rice) 1924

HUSTON, PRISCILLA J. *Manager of Systems Programming*

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

MCELROY, JAMES E. *Operations Manager*
B.A. (Houston) 1970

NICHOLS, CLYDE C. *Systems Programmer*
B.G.E. (Nebraska) 1965

PALING, WILLIAM A. *Assistant Director*
B.B.A. (Houston) 1968

Staff of the Health Service

CASSARD, LAWRENCE JAY. *Director, Psychiatric Service*
B.A. (Brooklyn College) 1944; M.D. (New York University College of Medicine) 1947

(To be appointed). *Medical Director, Student Health Service*

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

Staff of the Athletic Department

BALE, ALLEN MELBERT. *Assistant Director of Athletics*

BLACKWELL, DONALD M. *Assistant Coach of Football*

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

CONOVER, ALBERT P. *Assistant Coach of Football*

EGGERT, ALLEN. *Athletic Trainer*

ERFURTH, AUGUST F. *Business Manager of Athletics and Coach of Track and Field*

GIAMMALVA, SAMUEL ANTONE. *Coach of Tennis*

GOLDMAN, STEVEN E. *Coach of Freshman Football*

KNODEL, DON R. *Head Coach of Basketball*

LINVILLE, JOHN. *Assistant Coach of Football*

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

MEHAFFEY, GEORGE. *Assistant Coach of Basketball*

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

OSBURN, DOUGLAS EDWARD. *Coach of Baseball*

PECCATIELLO, LAWRENCE A. *Assistant Coach of Football*

PETERSON, WILLIAM E. "BILL". *Coach of Football and Director of Athletics*

PLUMBLEY, JOHN. *Coach of Golf*

ROBERTS, C. A. *Administrative Assistant to Director of Athletics*

ROSS, ROBERT J. *Assistant Coach of Football*

ROTE, TOBIN C. *Assistant Coach of Football*

ROTH, BERTRAM. *Band Director*

WHITMORE, WILLIAM ROGERS. *Sports Information Director*

WINBURN, RAY CRITTENTON. *Academic Counselor*

University Standing Committees 1971-72

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

Committee on Admissions: Mr. Giles, *Chairman;* Messrs. Akers, Stewart Baker, Burch, Donoho, Glass, Hungerford, Merwin, Minter, Morehead, Stevens, C. H. Ward and J. B. Wilson, Mrs. Gilmartin, Mrs. Sheldon and Mrs. Sobel; Mrs. Hellums, *consultant;* Mr. Donald Baker, *consultant;* an undergraduate student consultant: Mr. McEnany, *ex officio.*

Committee on Affirmative Action: Mr. Margrave, *Chairman;* Messrs. Bearden, Bourne, Dowden, Berling, O'Keeffe, Porter, Hodge, Cruz, Mrs. Paddock, Mrs. Murray and Miss Lee; Mr. Sadler, *ex officio.*

Committee on Campus Safety: Mr. Hightower, *Chairman:* Messrs. Bishop, Brooks, Charlton, Duck and Valkovic; Messrs. Berling and Rhodes, *consultants;* an undergraduate student member and a graduate student member.

Committee of the College Masters: Mr. Gruber, *Chairman;* Messrs. Donald Baker, Stephen Baker (1971-72), Castañeda, Curl, Havens, Philpott, Leeds and Rudee (on leave); Mr. McEnany, *ex officio.*

Committee on Computers: Mr. Resnikoff, *Chairman;* Messrs. Donoho, Feustel, Goldwire, Chad Gordon, Hayes, Hendren, Levy, Minnick and Rachford; Mr. W. E. Gordon, *ex officio;* a graduate student member.

Education Council: Mr. Wood, *Chairman;* Messrs. Ambler, Bearden, Eisenberg, Hayes, Higginbotham, Jones, Levin, Meixner, Shelton, Urrutibeheity and J. B. Wilson; Mr. Topazio, *ex officio.*

Committee on Examinations and Standing: Mr. McEnany, *Chairman;* Messrs. Castañeda, Dix, Estle, Lewis, Norbeck, Roberts and James L. Wilson; Mr. Morehead, *ex officio;* Mr. Parish, *consultant;* an undergraduate student consultant.

Faculty Council: Mr. Hackerman, *Chairman;* Messrs. Brotzen (1972), Rorschach (1972), J. A. Ward (1973), Walters (1973), D. Baker (1973), Bourne (1974), Pfeiffer (1974), Garside (1975), Kolenda (1975) and Margrave (1975); Messrs. Gordon, Topazio, Richter and Vandiver, *ex officio;* Mr. McEnany, *Secretary.*

Graduate Council: Mr. Hackerman, *Chairman;* Messrs. Gruber, Heymann, Isle, Leeds, Mitchell, Storck and Trammell; Mr. Vandiver, *ex officio;* Mr. Richter, *executive officer;* a graduate student consultant

Humanities and Social Science Research Council: Mr. J. A. Ward, *Chairman.* Messrs. Cooper, Chad Gordon, Hyman, Gordon Smith and Tyler; Messrs. Topazio and Vandiver, *ex officio;* a graduate student consultant.

Committee on Intercollegiate Athletics: Mr. Chapman, *Chairman.* Messrs. Castaneda, Duck, Minter, Rorschach and Vandiver; Mr. Humble (Alumni Association), Mr. Moore (R. Association), Mr. Law (Board of Governors) and Mr. Teague (Trustees).

Committee on the Library: Mr. Higginbotham, *Chairman;* Messrs. Davidson, Hayes, Lecuyer, Meixner and Warme; Mr. O'Keeffe, *secretary;* an undergraduate student member and a graduate student member.

The Rice University Marshals: Mr. Stewart Baker, *Chief Marshal;* Messrs. Campbell, Carrington, Cloutier, Garside, Grob, Huston, Risser and Soudek.

Committee on Public Lectures: Mr. Levy, *Chairman;* Messrs. Camfield and Vandiver; Mr. Hackerman, *ex officio;* Messrs. Emison and Shimek, *consultants;* an undergraduate student member and a graduate student member.

Committee on Religious Activities: Mr. Nielsen, *Chairman;* Messrs. Leland, Martin, Thomas, Tsanoff, Vann and W. F. Walker; an undergraduate student member and a graduate student member.

R. O. T. C. Committee: Mr. Carrington, *Chairman;* Messrs. J. A. S. Adams, Bowen, Gerhardt and Spence, Colonel Bishop and Captain Potter; an undergraduate student member.

Committee on Schedules: Mr. Curl, *Chairman;* Messrs. Feustel, Kelly, Stokes and Wilhoit; Mr. Morehead, *ex officio.*

Committee on Scholarships and Awards: Mr. McEnany, *Chairman;* Messrs. Estle, Gamst and Long and Mrs. Brown; Mrs. Hellums, *consultant.*

Science and Engineering Research Council: Mr. Brotzen, *Chairman.* Messrs. J. A. S. Adams, Dessler, Hellums, Levy, Margrave, Stebbings Thrall and C. H. Ward; Mr. W. E. Gordon, *ex officio;* a graduate student consultant.

Committee on Student Financial Aid: Mr. McEnany, *Chairman;* Messrs. Castaneda, Clark, Hudspeth, Merwin, Wann and Wierum.

Committee on Student Health: MR. BEARDEN, *Chairman;* MESSRS. BROOKS, CURL, EGGERT AND HOWELL; MR. WIERUM, *ex officio;* MESSRS. BERLING AND CASSARD, *consultants;* an undergraduate student member and a graduate student member.

Committee on Rice University Studies: MRS. DREW, *Chairman;* MESSRS. COOPER, FULTON, LEVIN AND PARISH.

Committee on Undergraduate Affairs: MR. MCENANY, *Chairman;* MESSRS. CURL, GRUBER, HAVENS, BURRUS, WIERUM AND MRS. HELLUMS; three student members; MR. VANDIVER, *ex officio.*

Committee on the Undergraduate Curriculum: MR. STEPHEN BAKER, *Chairman;* MESSRS. CHEATHAM, COOPER, GARSIDE, GREEN, MARGRAVE AND PATTEN; MR. MCENANY, *ex officio;* MR. PARISH, *consultant;* two undergraduate student members.

Committee on Undergraduate Teaching: MR. RORSCHACH, *Chairman;* MESSRS. STEWART BAKER, BROTZEN, BURRUS, DEANS, GARSIDE, B. F. JONES, SASS AND WANN; two undergraduate student members and one graduate student member.

Committee on University Welfare: (to be elected) *Chairman;* MESSRS. AMBLER (1972), W. F. WALKER (1972), BOWEN (1973), DAVIDSON (1973), KAPP (1974) AND LANE (1974); Faculty Council Representatives: MESSRS. GARSIDE, KOLENDA AND MARGRAVE.

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 through 1975, Beginning with the year 1965-66, tuition was charged by the University and a 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 the chief executive officer. At that time Dr. Croneis became chancellor and Dr. Houston honorary chancellor of the University. Dr. Pitzer served the University until the fall of 1968. Dr.

Frank E. Vandiver, Professor of History, served as acting president until September, 1970 when Dr. Norman Hackerman, president of the University of Texas at Austin, became the fourth president.

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.

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.

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, and the number of students will be raised to some 4,000. 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.

From 1949 the directing body of the University was the Board of Governors of fifteen members. This Board consisted of the seven permanent trustees and eight governors appointed by the trustees for staggered terms of four years. In 1968 four elected alumni governors were added, also with staggered four-year terms, increasing the Board of Governors to nineteen members. 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 forty 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, publications, and the campus radio station. Each of the residential colleges on the campus contains lounges, a dining room, and residential areas. Adjacent to each is the residence of the Master of the College and his family. Complete gymnasium facilities are open to all students. Cleveland Sewall Hall which is a major addition to campus facilities was opened in 1971. It contains modern facilities for the departments of anthropology, economics, education, fine arts, and sociology including classrooms, studios, and laboratories.

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, opened in 1968, provides additional space for mathematics, mathematical sciences and for systems research.

The Fondren Library houses more than 623,000 volumes (not including microforms, of which there are more than 381,000 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; the Hoffman Collection of Twentieth Century American and European Literature; the Nadler German language and literature collection, and extensive microform holdings of early American publications. A Graduate Library, completed in 1968, increased the total stack capacity to about 1,000,000 volumes. It provides additional carrels for the use of graduate students and faculty; a Graduate and Faculty Research Center where rare books, manuscripts and other special materials are housed; and added capability for expanding and extending a system of library computer applications.

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 Agnes Cullen Arnold Professorship In Fine Arts

The Arnold Trust established this Professorship in 1969 in memory of Mrs. Agnes Cullen Arnold, a Rice graduate and prominent Houston civic leader.

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

The Allyn R. and Gladys M. Cline Professorship in Economics and Finance

This Professorship was created by the estate of Miss Gladys M. Cline to encourage outstanding instruction in Economics and Finance, in which fields she and her brother were engaged for many years.

The Distinguished Professorship of Architecture

An anonymous donor established this professorship in 1971 to enhance the program of the School of Architecture.

The Favrot Professorship in French

This professorship was endowed in 1968 by the Favrot Fund and by the estate of Mr. Laurence H. Favrot, a Houston industrialist and member of the Rice Board of Governors.

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 Carolyn and Fred McManis Professorship in Philosophy

This professorship was created in 1969 by the McManis Trust in memory of the late Carolyn and Fred McManis, well-known Houston philanthropists during their lifetimes.

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 Harry K. and Albert K. Smith Chair in Architecture

In 1969, Messrs. Harry and Albert Smith endowed this new professorship to insure the continued excellence of the School of Architecture.

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 Tsanoff Chair of Public Affairs

This chair was established in 1967 by an anonymous alumnus to honor Professor Radoslav Andrea Tsanoff, who joined the Rice faculty in 1914 and has served the University continuously since.

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 Brown Foundation—J. Newton Rayzor Lectures

These lectures were established in 1971 by The Brown Foundation in memory of Mr. Rayzor, a Rice graduate and member of the Rice Board of Trustees.

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. At Mrs. Perkin's death in 1968, a substantial bequest provided an endowment for the support of appropriate facilities for outstanding instruction in musical theory and appreciation. Plans are currently in progress for the employment of a Director and the actual establishment of the school.

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.

Part Three

Information for Undergraduates

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

Curricula and Degrees

Rice University offers the Bachelor of Arts degree in arts and sciences, normally requiring four years for completion. Majors may be taken in anthropology, architecture, art and history of art, behavioral science, biochemistry, biology, chemical physics, chemistry, classics, economics and accounting, English, French, geology, German, health and physical education, history, linguistics, mathematical sciences, materials science, mathematics, philosophy, physics, political science, psychology, religious studies, Russian, sociology, or Spanish. An area major is also available. The Bachelor of Arts degree is also awarded on successful completion of four-year curricula in chemical engineering, civil engineering, electrical engineering, environmental science and engineering, mechanical and aerospace engineering or materials science, 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. 108-113.) 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 degree of Bachelor of Commerce is awarded after four years of study. Students completing the requirements for a four year bachelor's 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.

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.

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. (See p. 68.)

Undergraduate Curricula

The curriculum of each student working for the Bachelor of Arts degree in the Division of Humanities and Social Sciences and the Division of Science and Engineering is designed according to guidelines which may be divided into several areas: credit, distribution, concentration, skills and free options.

Credit. At least 40 courses, with associated laboratory, computation, or tutorial sessions as appropriate, must be passed. A course is defined as an approved offering of Rice University carrying at least 3 semester-hours of credit in one term.

At least 14 courses offered in fulfillment of the degree requirements must be at an advanced level (numbered 300 or higher).

Distribution. A student is expected to become acquainted with fields other than a single specialty or several closely related ones. To this end, a student should take courses outside of his area (s) of specialization or particular emphasis, distributing these courses according to the guidelines set forth below. At the end of each academic year the student should submit to his advisor for approval a proposed curriculum for the remainder of his undergraduate career. It is to be expected that this list will change as the student progresses but that it will continue to satisfy the distribution requirements.

At graduation, a student's entire course list (including courses in his major area) will include courses from at least five of the following six subject matter categories. The six categories are listed in pairs, and at least four courses must be chosen from each pair.

1. Literature and language
2. Fine arts, music, philosophy, and religion

3. Economics, history, and political science
4. Anthropology, behavioral science, linguistics, psychology, and sociology

5. Biological science, physical science, and engineering
6. Mathematics and logic

In some cases there will be courses which can be thought of as being in more than one of these categories. In such cases it is up to the student and his advisor to choose courses which still satisfy the spirit of the distribution guidelines subject to the approval of the Committee on Examinations and Standing.

If a student feels that neglecting two or more of these categories altogether is justified because he has already demonstrated competence in a particular category at the university level, then he may apply to the Committee on Examinations and Standing to have the distribution requirements appropriately modified.

Concentration. The choice of advanced work will be governed to a large extent by the student's area of concentration. Normally, the concentration will be defined by an authorized major program, and a student who chooses to satisfy the requirements of an established departmental or interdisciplinary major should associate himself with the appropriate department or program before registering for the junior year. The major program will specify a minimum of six courses for majors in the Humanities and Social Sciences Division and eight courses for majors in the Science and Engineering Division, and it will specify a maximum of 20 courses at any level, prerequisites and related courses included. Upon graduation, the student's transcript will indicate the name (s) of the major subject (s) for which the departmental or program requirements were satisfied.

Area Major. It may be, however that the educational goals of a student would be better served by a program of concentration which is not specified by an existing major program. In this case the student and his advisor should request that advisors from the two or more departments in which his major interests lie consult with them to construct a coherent program of concentration, not to exceed 20 courses, including pre-requisites and related courses. Such a student will be classified as an Area Major, and his transcript will indicate this with the names of the principal departments or programs which have cooperated in designing his program; for example: "Area Major in Biology and Mathematical Sciences," "Area Major in Germanics, History, and Sociology," etc.

Skills. *English Composition.* It is expected of every recipient of a degree that he can demonstrate facility in English comprehension and composition. His competence can be demonstrated by an acceptable score on an examination specified by the English Department and taken at the beginning of the freshman year or by satisfactory performance in an English tutorial during the freshman year.

Physical Education. Each freshman student must include two courses (non-credit) in Basic Health and Physical Education in his curriculum.

Free Options. The student is free to choose any other courses open to him to complete the course requirements for graduation. He may, if he wishes, intensify his concentration in a single discipline or he may explore other areas and thus enhance his distribution, or use these options to qualify for a teaching certificate or fill medical or dental school entrance requirements.

Division of Humanities and Social Sciences

Majors are offered in anthropology, art and art history, behavioral science, biology, classics, economics and business administration, English, French, geology, German, health and physical education, history, linguistics, mathematics, philosophy, political science, psychology, religious studies. Russian, sociology and Spanish. There are no specific courses required by all departments and, therefore, no suggested course of study available. In the freshman year, however, the skill requirements described on p. 63 must be satisfied. The requirements for each major are available from the chairman of the department, or from the Registrar's Office.

The degree program of each student is planned in consultation with his advisor. Courses of future years must be projected at the time of registration each year to assure that credit, distribution and concentration requirements will be met by the expected date of graduation. It is usually desirable for students to include at least half of the distribution requirements in the first two years, leaving more free options for later when the student's interests and future plans are more firmly crystallized.

Science-Engineering Division

Science and Mathematics

Majors included in this program are biochemistry, biology, chemical-physics, chemistry, geology, materials science, mathematical sciences, mathematics and physics. Students majoring in one of the sciences should take the following courses early in their programs since they are prerequisite to courses required in most majors.

Mathematics 101a, 102b, 201a, 202b (or equivalent honors courses)
Physics 100a, 100b, 130b
Chemistry 101a, 103a and 102b, 104b

In the freshman year the skill requirements described on p. 63 must be satisfied. The requirements for each major are available from the chairman of the department, or from the Registrar's Office.

The degree program of each student is planned in consultation with his advisor. Courses of future years must be projected at the time of registration each year to assure that credit, distribution and concentration requirements will be met by the expected date of graduation. It is usually desirable for students to include at least half of the distribution requirements in the first two years, leaving more free options for later when the student's interests and future plans are more firmly crystallized.

Engineering

Students interested in engineering as a profession may major in chemical engineering, civil engineering, electrical engineering, mechanical and aerospace engineering, or materials science. The following specific courses are required by all departments:

Mathematics 101a, 102b, 201a, 202b (or equivalent honors courses)
Physics 100a, 100b, 130b

Other 100-level and 200-level courses required by one or more departments:

Chemistry 101a, 103a and 102b, 104b, 210a, b
Physics 210a, 210b, 230a
Engineering 211a, 200b, 240a or 240b, 241a or 241b

The degree program of each student is planned in consultation with his advisor. Courses of future years must be projected at the time of registration each year to assure that credit, distribution and concentration requirements will be met by the expected date of graduation. It is usually desirable for students to include at least half of the distribution requirements in the first two years, leaving more free options for later when the student's interests and future plans are more firmly crystallized.

During the first two years engineering students should consult with the chairmen of the departments of interest or the Dean of Science and Engineering for information and advice about details of the programs and choice of electives, and about engineering as a profession. Before registering for the junior year each student must associate himself with an adviser in the department of his major choice. His registration for every semester thereafter must be approved by an adviser in his major department.

A program of studies for the first two years which satisfies the requirements of all the engineering departments is given below. Such a program maintains the option of easy entry to any department in the junior year. Programs which satisfy the requirements of one, two, or three departments would eliminate one or more of the courses shown and would constitute more normal programs. Although a student may take courses in arbitrary order provided prerequisites are satisfied, he must plan ahead to assure that all of the degree requirements will be met eventually and he should pay particular attention to the prerequisite courses of his intended major. It is strongly recommended that every student discuss this program with an adviser in the department in which he expects to major before registering for his second year.

First Year

(1) Mathematics 101a, 102b (or corresponding honors courses)
(2) Physics 100a, 100b, 130b
(3) Chemistry 120a, 120b
(4) Electives
(5) Electives
(6) Basic Health and Physical Education
(7) R.O.T.C., if elected.

Second Year

(1) Mathematics 201a, 202b (or corresponding honors courses)
(2) Physics 210a, 230a, 210b
(3) Engineering 240a or 240b, Engineering 241a or 241b
(4) Engineering 211a, Engineering 200b
(5) Chemistry 210a, b
(6) R.O.T.C. if elected

School of Architecture

The University requires a minimum of forty courses for the degree of Bachelor of Arts with conditions for distribution as set forth on page 62 of the *General Announcements.* The required courses of the curriculum listed below satisfy numbers 2, 5 and 6 of the distribution categories. It is the student's responsibility to insure that his electives in architecture and university courses fulfill the other category distribution requirements. At least twenty courses in the B.A. degree program must be in courses other than architecture. The courses named below for the first and second years are required, and are normally taken in the sequence shown.

First Year

(1) Architecture 101a, 102b
(2) History of Art 205a, 206b
(3) Physics 101a, b and 103a, b; or Physics 100a, b and 130b
(4) Mathematics 103a or 101a and elective
(5) Electives
(6) Health and Physical Education

Second Year

(1) Architecture 201a, 202b
(2) Architecture 203a, 204b
(3) History of Art 345a, 346b
(4) Art 225a, 226b
(5) Electives

Third and Fourth Years

In addition to the required courses listed below, an additional minimum of eight courses in architecture is required, three of which must be in studio design. These are normally taken in the third and fourth years. Architecture 303a, 304b and 315a are required for admission to the professional program in architecture leading to the degree of Bachelor of Architecture.

Program in Commerce

A minimum of forty courses are required for the degree of Bachelor of Commerce. At least fourteen of the forty must be advanced courses (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 appropriate courses in other curricula of the University may be substituted for required commerce courses. Candidates for the Bachelor of Commerce must satisfy the distribution and skills requirements described on pp. 62 and 63.

The degree program of each student is planned in consultation with his advisor. Courses of future years must be projected at the time of registration each year to assure that credit, distribution and concentration requirements will be met by the expected date of graduation. It is usually desirable for students to include at least half of the distribution requirements in the first two years, leaving more free options for later when the student's interests and future plans are more firmly crystallized.

Program in Health and Physical Education

A total of forty courses must be presented for a major in Health and Physical Education. The distribution and skills requirements described on pp. 62 and 63 must be satisfied as well as the specific requirements of the department. They are as follows:

Biology—2 semesters
Heal 100a-110b (125a-126b labs)
Heal 210a-205b (225a-226b labs)
Heal 300a-310b (325a-326b labs)
Heal 320a-321b-305a
Heal 400a-410b (425-426b labs)

Biology and Health 100a and 110b should be taken very early in the program since they are prerequisites for many succeeding courses.

The registration card of each student must be signed by a member of the Faculty of the Department after the sophomore year.

Students wishing to qualify for teacher certificates by the Texas Education Agency must complete 6 hours of American History, 6 hours of Federal and State Government, 18 hours of Education, and 24 hours in a second teaching field. Students electing this course of study may select any Health courses totaling 24 semester hours. (The laboratory courses are strongly recommended). Health 100a-110b is required of all Health and Physical Education teaching field students.

Basic Health and Physical Education (101-4) could substitute for Heal 125a-125b (labs) with the completion of a Water Safety Instruction Course and by approval of the department.

The degree program of each student is planned in consultation with his advisor. Courses of future years must be projected at the time of registration each year to assure that credit, distribution and concentration requirements will be met by the expected date of graduation. It is usually desirable for students to include at least half of the distribution requirements in the first two years, leaving more free options for later when the student's interests and future plans are more firmly crystallized.

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 171 for details.

Premedical, Predental and Prelaw Studies. Courses required for admission to any accredited American medical, dental 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.

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. Priority for selection of students who wish to complete the Basic Course by the latter method goes to transfer students, graduate students, and other students who did not have an opportunity to complete the Basic Course by the on-campus method. Upon completion of the Basic Course by either of these methods, the student, if recommended for further training, may elect the Advanced Course.

On-campus courses include one hour per week of Leadership Laboratory for Freshmen, Sophomores and Seniors. Juniors, and those Seniors that have not attended the Advanced Course Summer Camp, attend Leadership Laboratory two hours per week.

Basic Course Freshmen attend class one hour per week and Sophomores three 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 by the Army for the period of his scholarship. Nonscholarship students receive $50.00 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 Scholarship 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 (Scholarship); (2) Contract.

Regular (Scholarship) Students. A regular scholarship 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 required to complete prescribed naval science courses plus 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 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 competitive procedure indicated above for Regular (Scholarship) students; rather they are selected by the Commanding Officer (Professor of Naval Science) from among those students who apply and are either selected for admission by Rice University or are already in attendance.

U. S. Marine Corps. N.R.O.T.C. students, either Regular (Scholarship) 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.

A Flight Instruction program is available to physically qualified Regular (Scholarship) and Contract students. It consists of 40 hours of flight instruction and 35 hours of classroom instruction, conducted by a local flying school. All expenses, including travel, are paid by the government. Juniors, Seniors, and Fifth-year students are eligible.

Academic Regulations

All students seeking a bachelor's degree and those enrolled in the fifth year program leading to a professional degree in accounting, architecture or engineering 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

Currently enrolled students complete registration in May for the following academic year except for payment of fees. All tuition and fees must be paid by August 16, except where a special tuition plan has been elected. 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 be eligible to continue and pay a $25 reinstatement fee. Entering students are sent preliminary registration materials during the summer, but course registration is completed during Freshman Week.

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. Entering transfer students are assigned advisers similarly.

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 a student's registration is a result of modification of the course offerings or class schedules of the University.

Course Programs

A student at Rice normally enrolls in five courses each semester and thus, in eight semesters completes the forty courses required for graduation. A student may, however, elect to enroll in only four courses in any four of the eight semesters. Any student not on academic probation may register for up to six courses for a given semester with his advisor's approval. Variations from these acceptable course loads must be approved by the Committee on Examinations and Standing.

Reduced Course Load

Some students may find it desirable or expedient to enroll in only four courses or drop a course during the term. This is permissible with the adviser's approval in any four semesters of the normal eight semesters of residence. No course may be dropped, however, after the end of the tenth week of the term nor can a student reduce his course load below four courses without specific approval of the Committee on Examinations and Standing. In all cases the student should be cognizant of the effect of a reduced load on his future schedule, his eligibility for academic honors and the options open to him for completing the degree requirements.

A student failing to complete a first baccalaureate degree within eight semesters but lacking less than a full year's work 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 83.

Removal of Course Deficiencies

Course deficiencies may be removed by taking an extra course in future semesters, by transfer credit for approved courses in a summer school or by extending the period of residence.

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 summer school courses taken to remove deficiencies, nor is credit for future courses in a student's program granted for work done in summer school. Financial aid is not available for summer school work and tuition grants are awarded only for the normal four (or five) year period of residence.

Approval of Degree Plans and Majors

With his course registration each year (except the freshman year) every student must file a degree plan with the Registrar. His degree plan must be approved by his adviser and must include: (1) his major(s), (2) courses completed to date, (3) proposed course lists for each subsequent year which will show how major requirements and distribution requirements will be met, and (4) his expected date of graduation.

A student who wishes to propose a degree plan which varies from the normal requirements for the degree sought, as described on page 62 of these announcements, may submit it to the Committee on Examinations and Standing for approval. Appropriate explanation and justification must be provided.

A student's degree plan may be changed at any time simply by filing a new properly approved plan with the Registrar.

Examinations

Written three-hour examinations are given in all undergraduate courses at the close of each semester. 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. 99). 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; WD-Withdrawn. Grades for the first semester are recorded in January and for the second semester in May.

Any student may enroll in one course outside of his major field on a pass-fail basis in any four semesters of the normal eight semester program. In any major, however, the Department may specify certain courses outside the major as not available for the pass-fail option in that major.

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 fifth 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 carrying at least five courses who have no grade less than 2 in any course, or 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 apply for permission to register 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 an application is under consideration, the committee will request reports and recommendations from the members of the faculty and others 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, on application to the Committee on Examinations and Standing. 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.

Leave of Absence

Any student eligible to continue in the University may apply to the Committee on Examinations and Standing for leave of absence to be effective at the end of a term or semester. Leave may be granted for up to four consecutive semesters, but the student may re-enroll for any semester during his term of leave without application for re-admission. He must, however, notify the Registrar of his intention to register at least one month prior to the beginning of the semester.

This provision for leave of absence encourages students to take "time out" when interest is lagging or personal problems are interferring with educational progress. The above regulation of Voluntary Withdrawal applies primarily to students who leave during a term.

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

Since the early years of its history the size of the freshman class at Rice University has been limited to a specific quota. This has been necessary to establish and retain the distinctive nature of Rice as a small, personal university. Some expansion of the student body has been permitted, particularly over the last two decades, but only as funds have become available for building new facilities, increasing the faculty and establishing new programs.

Because of the limited number of places available the Admissions Committee must select the members of the freshman class from among a large number of applicants. In making selections the Committee undertakes to identify students who have demonstrated exceptional ability, talent and potential for continuing development and accomplishment irrespective of sex, race or creed. Decisions are not based on grades or test scores alone. Consideration is also given to such qualities as leadership, participation and personality. The aim, however, is diversity rather than uniformity. Therefore the class will include some with exceptionally high qualifications in some areas, as well as many well-qualified in terms of all criteria.

The measures used are of four 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; 3) evaluations made by teachers and counselors; and 4) the personal interview. 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.

Students are selected on a competitive basis in accordance with admission quotas in the (1) Architecture, (2) Humanities and Social Sciences, (3) Engineering, and (4) Science programs of the University. New students enter only in the fall term.

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	Additional credits in above-listed subjects	3
*Mathematics (algebra, geometry)	3		
A foreign language	2		
	Total 16		

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 C.E.E.B. bulletins and test applications are available from high school counseling offices. They may also be obtained in the Rice admissions office for those who find it convenient to call for them.

The following examinations are required according to the curriculum selected:

A. Humanities and Social Sciences

(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 Cultures
  - Literature
  - Mathematics
  - A science

B. Science and 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

C. Architecture. The same as *A.* above plus the Architectural School Aptitude Test

The courses of study and majors offered may be found on pages 61-68.

3. *Evaluations from High School Counselors and Teachers.* Confidential rating sheets submitted by the applicant's high school teachers and counselors are considered in connection with every application.

4. *Personal Interviews.* Interviews are an integral part of the admission procedure. They enable the Committee on Admissions to reach a decision based on nonacademic, as well as academic, aspects of the can-

* Preparation in chemistry, physics, trigonometry and additional advanced mathematics courses is highly recommended for applicants for the Engineering and Science Divisions

didate'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 9:00 A.M. and 4:00 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.

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. Early Decision candidates applying in the School of Architecture may take the Architectural School Aptitude test during their senior year. The personal interview requirements may be satisfied at any time prior to the October deadline. Early Decision applicants will be notified of the Admissions Committee's decisions on or about November 15.

Action on some applications 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 test 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. Information concerning residence on the campus will be sent in April to all students admitted under the Early Decision Plan.

Regular Decision Plan

The Regular Decision Plan is primarily for candidates 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 on or about April 10. 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.

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	April 10
Candidates Reply Date (with registration deposit)	December 1	May 1
**Room Deposit	May 15	May 15

* No application fee is required of candidates for admission to Rice.

** Room application forms and information concerning residence in the colleges will be sent in April to the Early Decision admissions. Regular Decision admissions receive their information at the time admissions are granted.

Advanced Placement

Entering freshmen 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, mathematics (BC level), 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 the freshman year.

Departmental placement examinations in foreign languages are given on the campus in the fall. A satisfactory grade does not give the student degree credit for these courses. 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.

The Rice Tutorial Program

Departments with major teaching assignments provide tutoring to freshmen having academic difficulty. Each participating department has named a faculty Department Tutor who has the responsibility for organizing tutoring activities and assigning students who need tutoring to groups or individual tutors. Assignments are made on a mutually agreeable basis after consultation.

Each Residential College has selected a faculty associate who has agreed to serve in a liaison capacity. He seeks ways to aid communication and help with the advising of freshmen who may need tutoring. The entire tutoring program is under the supervision of a faculty member who acts as Program Coordinator.

Anyone may recommend or request tutoring for an individual freshman. A student who feels he needs help may request that help. The normal procedure is to consult with his course instructor or the Department Tutor. However, his College Liaison Associate or the Program Coordinator is available to consult with and assist any student.

Transfer Students

Rice University encourages application from students with superior records who wish to transfer from a junior college or a four-year college or university. Interested students should request the Preliminary Application for Transfers from the Office of Admissions.

The applicant should file a preliminary application between February 1 and April 1 if he plans to request admission for the following September. It must be accompanied by official transcripts showing all college-level work completed to date and courses in progress. To be considered for admission he must present credit for no less than ten courses, equivalent to 3 semester hours credit each, which could be applicable to the degree he will seek at Rice. After evaluation of the preliminary application the candidate is sent the remaining application forms if he is considered eligible.

A minimum of two years in residence is required for a Rice degree. New students enter only in the fall term. Decisions regarding transfer applications are usually made during May.

The criteria used in evaluating transfer applications are essentially the same as those applied to applicants for the freshman class, except that greater weight is given to the grade record in college-level courses than to other factors. C.E.E.B. test scores are required. If a candidate has not previously taken them, he must take the Scholastic Aptitude Tests no later than March. The Achievement Tests are usually waived in such cases.

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 must clearly indicate that he is a prospective transfer from another college.

Student Housing

A prospective student should indicate on his application for admission if he desires to reside on the campus. Information about residence in the colleges and room application forms will accompany the notice of admission sent to each new undergraduate. Arrangements for room reservations cannot be made prior to notification of admission. Undergraduate women students under 21 years of age not living at home must live in one of the women's colleges unless their parents or guardians advise the master of the college in writing, and furnish him their off-campus address.

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 are as set forth below. These charges are subject to change from time to time as the operating expenses of the University increase.

Tuition

The tuition for undergraduate students who entered Rice University in August 1970 or later is $2,100 per year, payable $1,050 at the beginning of each semester.

The tuition for undergraduate students who entered prior to 1970 will be as described in the General Announcements for the year of their entry provided they have continued without interruption.

An undergraduate who withdraws or takes a leave of absence from the University is charged the same tuition as is being paid by the members of the class he enters on his return.

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) is 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 $90 per semester hour plus a $50 per semester registration fee up to but not exceeding the full tuition charge.

Fees

All undergraduate students and candidates for a second Bachelor's degree will be charged the following annual fees. These fees are paid at the beginning of the term in the fall.

Subsidies to students' activities	$15.65
Tickets to athletic events	4.00
College fee	20.00
Health Service	23.00
Total fees	62.65

In addition, an undergraduate student who entered prior to September, 1969 will pay a laboratory fee of $10.00 per semester for each of the laboratory courses in which he is registered.

Special Charges

Freshman Week	$20.0C
Late Registration, per week or fraction thereof	15.00
Late Change of Registration, each course	10.00
Reinstatement fee	25.00
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 during the first week of classes, 90 per cent of the tuition paid will be refunded. Thereafter, the amount of the refund will be reduced by 10 per cent of the total tuition charge at the beginning of each successive week that the student remains enrolled. There is no refund of fees or special charges after a student once attends classes.

Teacher Certification Program Fees

All students enrolling in either the Apprenticeship Plan or the Internship Plan will be charged a $100 registration fee for each semester or summer period.

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 payments of current charges, or anyone moving on campus without executing a satisfactory room contract, 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 advance. Those requesting transcripts by mail should include payment with the request.

Living Expenses

Residence fees, to cover costs of dining halls and operation of residences, are established from year to year as requirements dictate. For

1971-72 the yearly fee for residence in the men's colleges is $1,235.60, in the women's colleges $1,306.60. 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 holidays, mid-year and Spring mid-term recesses, and the Easter holidays. 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 1st. New students are required to make a similar deposit prior to May 15th. These deposits are returnable only upon individual application and for good and sufficient cause. The balance of the residence fee is payable in two installments. The exact amounts and due dates are stated in the Residential college Agreement which each on campus resident is required to sign.

All items included, the young man or woman entering Rice University in September 1971 who will live on campus wil need to have available about $4,200 for the first year. For a student living at home the cost will be about $3,700.

Financial Aid

The purpose of the financial aid program of Rice University is to provide assistance as needed in meeting the basic costs of attendance to all students who are admitted. Through low interest loans, tuition grants or a combination of loan and grant the program attempts to give students sufficient aid to meet educational expenses.

The financial aid program is funded from contributions of alumni and friends to various loan funds, the federal student loan program, and a generous tuition grant appropriation and a loan appropriation from endowment income. These provide a limited amount available for aiding all students. Therefore awards are based primarily on financial need. It is assumed that (1) students will rely upon their own resources as much as possible and will make reasonable efforts to increase them through summer work and other sources which may be available to them, (2) student expenses will be held to a reasonable minimum and (3) parents will contribute in proportion to their means and other obligations.

Determination of need is based on information supplied through the College Scholarship Service.

To apply for financial assistance a candidate must file the Parents' Confidential Statement with the College Scholarship Service. When Rice University receives it from the College Scholarship Service the applicant is considered for all appropriate grants and scholarships administered by the University. No other application is needed.

Early Decision candidates obtain Parents' Confidential Statement forms from the Office of Admissions or the Financial Aid Office at Rice. They must be filed with the College Scholarship Service by October 1.

Regular Decision candidates secure Parents' Confidential Statement forms from high school counselors or from the College Scholarship Service, Box 176, Princeton, New Jersey 08540. They must be returned to the College Scholarship Service by February 1.

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.

Continuing students must file application for renewal of financial aid each year by submitting the Parents' Confidential Statement to the College Scholarship Service. This should be done by March 1. Since awards are based on need which may change from year to year, the amount of assistance is reviewed each year as related to current need. Awards are adjusted when a student's resources and his family's circumstances change significantly.

Financing. In some cases meeting the costs of higher education in a private university is difficult even though the usual financial analysis indicates no need for financial aid. It is understood that even though a family's assets may be adequate to afford the costs of tuition, fees and room and board without financial aid payment of relatively large sums at stated times may require rearrangement of family planning that results in hardship or sacrifice. Rice University offers two payment plans to permit financing of educational costs. Both require very low interest charges.

A short-term Ten-pay Plan permits division of the annual university charges over an equal number of months. Arrangements are made through the Cashier's Office, from which details and applications may be obtained.

Longer term financing is available through the Rice University Loan Fund to those for whom lump sum payments would require undue hardship. Under the terms of this plan a student might borrow up to two thousand dollars in one year. Interest is not charged so long as the student is registered in the University. Upon graduation or withdrawal, arrangements may be made for repayment over an extended period, interest being charged at a very nominal rate.

Student Loan Funds

A few endowments have been established for student loans primarily as memorial tributes. Others are welcome. These funds are basically part of the normal financial aid program. They are used also, however, for emergency loans to students who experience unexpected financial problems during a term.

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 Cladwell.

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 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

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.

It is strongly recommended that students in their first year do not plan part-time employment unless absolutely necessary to meet expenses. A college program is a full-time job requiring fifty to sixty hours per week to do justice to the educational opportunities presented. In addition, every student should take advantge 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.

Undergraduate Scholarships

Honor Scholarships

Designation as an Honor Scholar is made solely on the basis of outstanding scholarship. Students so named have earned very high standing in all courses during the last two semesters preceding their selection.

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

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 worthy students.

Brown Awards in Egnineering. Established from funds made available by Mr. George R. Brown in 1968, these awards recognize students entering the freshman year in engineering with outstanding records and high potential as future engineers.

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.

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 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.*

Gaylord Johnson Scholarship. In 1968 the family of the late Gaylord Johnson established an annual award in his memory to be given to an undergraduate student who has achieved academic distinction in a program of studies which relates to problems affecting human relations.

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.

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.

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

General Scholarships

Many friends of Rice University have endowed scholarships to honor a relative or distinguished friend, or in the name of an organization, association or club. These awards recognize superior scholarship, giving encouragement and financial assistance to many worthy students. They are reserved principally for students in the upper classes, although some are designated for entering freshmen. Scholastic standing and need for assistance are considered in selecting recipients, with proper consideration given to course of study, class, place of residence or other stipulations in accord with the wishes of the donor. Application is not made for these named scholarships. All students who satisfy the stipulations are considered potential candidates.

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

Joe L. and Barbara Albritton Scholarship. Established by the named donors in 1971 to assist students with excellence of achievement in studies.

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.

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.

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 Ellen 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.

James A. and Alice Graham Baker 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.

Fletabel Denton Briggs Memorial Scholarship. Established under the will of the late D. Todd Briggs in memory of his wife. First awarded in 1971.

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.

Class of 1921 Scholarship. Established in 1971 by members of the named class on their 50th Anniversary, to assist an entering Freshman.

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.

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

Joseph I. Davies Scholarship. Established by friends in 1966 in honor of the late Dr. Davies, Professor of Biology, to assist undergraduate students.

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

Thomas P. and Maude Seeger Dow Scholarships. Established in 1968 under the will of Maude Seeger Dow to assist undergraduate students.

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 Professional Master's degree in one of the four branches of engineering.

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.

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.

Goldston Scholarships. Established by Mrs. Walter Goldston through the Goldston Endowment, Inc., to assist promising and worthy students.

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.

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.

Mercer T. Ingram Scholarship Fund. Established to assist undergraduate students.

Instrument Society of America Scholarship Fund. Established in 1967 to afford incentive for scholastic achievement and academic performance. Awarded to a student of Junior or Senior standing majoring in science and/or engineering.

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.

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 Scholarships. 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 engineering, physical science, or related fields.

Mason G. Lockwood Engineering Scholarship. Presented to a Fifth Year engineering student with an outstanding scholastic record in his first four undergraduate years at Rice.

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.

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.

O.W.L.S. Alumnæ Scholarship. Established in 1969 to assist a needy Senior girl.

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.

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

Robert H. Ray Memorial Scholarship. Established in 1968 by Mandrell Industries, Inc., in honor of alumnus Robert Hillyer Ray. This four-year scholarship is awarded to an incoming Freshman with first preference given to children of Mandrel employees.

Ernest R. Rechel Memorial Scholarship. Established under the will of Frances C. Rechel in memory of her son, Rice alumnus Ernest R. Rechel, to assist a deserving student. First awarded in 1968.

William J. Reckling Memorial Scholarship. Established in 1967 by T. R. Reckling, III, in honor of his father, to be awarded to worthy students majoring in French.

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.

Edith Ripley Scholarships. Established 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.

Kathleen Elaine Schlotterbeck Memorial Scholarship. Established in honor of their late daughter, a Rice student, by Mr. and Mrs. W. K. Schlotterbeck, to benefit a needy student.

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

Jackie Schnell Memorial Scholarship. Established in 1968 in honor of Brown College student the late Diane Jackie Schnell.

Society of Rice University Women Scholarship. Established in 1970 to aid deserving women students.

John Stauffer Scholarships in Chemistry. Established by the above donor in memory of the late E. S. Rothrock, formerly a director of Stauffer Chemical Company and an alumnus of Rice University. Tuition Scholarship awarded to a student in the field of chemistry.

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

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

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.

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 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 and 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 *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 *Edward B. Arrants Medal* is awarded annually to a student who shows outstanding 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 brochures submitted in application for admission to Class II Graduate Standing.

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 *Rice Engineering Alumni Scholarship Award* is presented to the outstanding fourth-year engineering student on the basis of scholarship and other qualifications as judged by the Engineering Alumni Association.

Mary Hayes Ewing Publication Prize in Southern History was established in 1967 by the late Andrew Forest Muir to be awarded annually to a Rice student or former student for the best article on southern history published in a journal during the immediately prior year.

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 *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 *Barbara Field Kennedy Prize in American History* is awarded annually to the undergraduate or graduate student whose overall academic performance is rated highest by the Faculty of the Department of History.

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

The *Z. W. Salsburg Memorial Scholarship* was established in 1970 in honor of Professor Z. W. Salsburg in recognition of his devotion to excellence and interest in students. It is awarded annually to outstanding Chemistry students.

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.

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 if these standards are disregarded by others. It is assumed that students, having voluntarily enrolled in this 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. The University examines continuously its presuppositions and practices. Students are encouraged to participate in this process through appropriate examination, 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 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. Such action will ensue 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.

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 eight colleges. Baker, Hanszen, Richardson, Wiess, Will Rice and Lovett are the 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 Assistant to the 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 is 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, composed of the president, two vice-presidents, secretary, treasurer, the college presidents, and an off-campus representative.

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. Rice engineering students publish the quarterly *Rice Engineer.* The Student Program Council sponsors various programs of current interest to the student body. A campus radio station, KTRU, is operated by students on a 24-hour, 7 days a week schedule; the station broadcasts both AM and FM.

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 Engineers, 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 interest. 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.

Women Students may affiliate with one of the two literary societies—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.

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.

Mentor Recognition Award

The Student Association established this award in 1970 to recognize extraordinary service to the student body by a current member of the faculty or staff.

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. An appointment may be made directly by a student, or anyone he delegates, either by phone or in person at the Office of Psychiatric Service in Lovett Hall. 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 provide offices for the Dean of Students, the Association of Rice Alumni, the Placement Office, 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.

Placement Office

The Placement Office is a service provided by Rice University to assist students and alumni in finding employment. Facilities are available for the use of representatives from business, industry and schools while interviewing students and alumni for prospective employment.

Lists of permanent, part-time and summer employment opportunities are kept. Also, files are kept giving information about and qualifications for various professions and occupations.

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 of 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 parking 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, political science and in interdepartmental areas. The number of graduate students steadily increased. Within the next few years expansion will continue.

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 Masters degrees 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, mathematical sciences, mechanical and aerospace engineering and materials science, philosophy, physics, political science, psychology, religious studies 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, environmental science and engineering and materials science. The Master in Architecture is also offered. Professional degrees awarded are the Master of Chemical Engineering, Master of Civil Engineering, Master of Electrical Engineering, Master of Environmental Science, Master of Environmental Engineering, Master of Materials Science and Master of Mechanical Engineering.

For specific information, refer to the statements of various departments in *Part Five,* pp. 119-297. 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 courses after completing the requirements of the first four years of the corresponding engineering major or the equivalent. The program ordinarily includes at least eight science or engineering courses at the 500 or 600 level but may include appropriate courses at the 400 level. The program may include two courses in the humanities or social sciences at the 300 level or above. Programs which depart from these guidelines must have specific approval of the Committee on Professional Master's Degrees. The program must be approved by the student's adviser in his major department. The student is recommended for the degree by his department if he achieves in the approved program either a grade average of 3.0 in all courses attempted or 2.5 average in the courses attempted in his major field.

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 department 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 bioengineering, systems and information theory, solid-state and physical electronics, and computer science, and engineering.

Environmental Engineering. Proper course planning will permit specialization in water resources, air resources, pollution control process design and optimization, mathematical modeling, applied mathematics, urban systems and environmental planning.

Environmental Science. Flexibility in choice of electives permits concentration in such areas as the biology, physics, chemistry, and geology of environmental planning and management, pollution detection and control, applied mathematics, and urban systems analysis.

Materials Science. After successful completion of the Rice B.A. major in Materials Science one may proceed to the Professional Masters Degree in Materials Science in the following way: Ten courses in Materials Science or related fields are to be chosen by the candidate in consultation with the department adviser.

Mechanical Engineering. For properly qualified students, flexibility in course requirements permits 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 department chairman to the Graduate Council for the approval of candidacy. The chairman will certify that the applicant has fulfilled the department requirements 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 beginning of Examination Week in either semester 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 examination 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 120.

By special arrangement 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 to part-time students. Full-time tuition the previous academic year will provide for exemption of these fees.

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.

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 recommendations, 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 of 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, mathematical sciences, engineering, physical science, or social sciences. Programs of instruction utilize common courses in systems theory and mathematical sciences, 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, 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 Communication Theory. For applications or additional information, contact the chairman of one of the following departments: Chemical Engineering, Economics, 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.

An interdisciplinary program in Bioengineering leading to the degree of Doctor of Philosophy is open to students with backgrounds in engineering, mathematics, physics, or biology. The curriculum offered involves not only an extensive introduction to physiology, biophysics and laboratory methods, but also the analysis, modelling and instrumentation of biological systems. Additional courses include the areas of systems science, modern control theory, computer science, communication theory, biology, chemical engineering, and mathematical sciences. Also, courses offered by Baylor College of Medicine are available to satisfy special needs and interests of the student. The present research areas include: the cardiovascular and cerebrovascular systems, vision research, neurophysiology, biological control systems, ultrasound applications to biological systems, and mechanical receptor physiology. For applications or additional information, contact the chairman of the department.

Tuition, Fees, and Expenses

Tuition for full-time students enrolled in the Graduate Division is $2,300 per year, payable $1,150 at the beginning of each semester. In addition, each graduate student pays an annual Health Service fee of $23 and a Graduate Student Association fee of $3.00.

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 $125 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 time tuition rate.

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 in 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 fields. 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.

Ora N. Arnold Fellowspip 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 Philippine 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.

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.

Ethyl Corporation Fellowship in chemical or mechanical engineering.

Gillette Fellowship in chemistry.

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 chemistry.

Schlumberger Foundation Fellowship in mathematics.

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

Standard Oil of Indiana Fellowship in environmental science and 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.

Texas Company Fellowship in chemical engineering.

Union Oil of California Fellowship in geology.

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

William Ward Watkin Memorial Traveling Fellowship in architecture. Provided by the alumni of the School and the Rice Architectural Society, the award, based on competition open to seniors, honors the memory of the first chairman of the Department of Architecture.

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 $2,300 for the tuition. Appointees must be engaged in full time graduate study and agree not to accept other employment during tenure.

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 must carry a full schedule of graduate work and agree not to accept other employment during tenure.

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 National Science Foundation Fellowships as well as by awards made from grants to the University through such agencies as the National Institutes of Health. Appointees must be engaged in full time graduate study and agree not to accept other employment during tenure.

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 *MacAgy Award* is given each year, if appropriate candidates are available, to one or more outstanding senior Fine Arts majors, upon recommendation of the Faculty, for postgraduate study and travel.

The *Captain Charles Septimus Longcope Awards* are given annually for the best master's thesis in History and the best doctoral dissertation as selected by the Department of History.

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. The University examines continuously its presuppositions and practices. Students are encouraged to participate in this process 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 if 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 the University. 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 achievements 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. 99.

Graduate Student Government

All full time graduate students are members of the Graduate Student Association. It is the sole organ representing the graduate students as a body. Part time graduate students may become members of the association upon payment of the respective fee. The governing body of this organization is the Graduate Student Association Council consisting of a chairman, a secretary, a treasurer, and a representative from each department offering graduate study.

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.

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 102.

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 61-68 and 108-110.

Course numbers below 300 are lower-level courses. Those numbered 300-499 are designated as advanced courses. They are open to students of the lower classes with proper prerequisites 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 201a 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 101a, b or Architecture 101a, 102b, 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 316b, 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

Professor Todd, *Director;* Professors Caudill, Conant, Evans, Krahl, Mitchell, Morehead and Ransom
Associate Professors Cannady, Hendren and Long
Adjunct Associate Professor France
Assistant Professors Erdman, Kilper, Papademetriou, S. W. Parsons, Schorre and Scott
Adjunct Assistant Professor Leifeste
Lecturers Britton, Dyess and Mixon
Instructor Parks

Preceptors Plan A

Richard L. Aeck, F.A.I.A., Aeck Associates
Atlanta, Georgia
Max Flatow, F.A.I.A.
Albuquerque, New Mexico
O'Neil Ford, F.A.I.A., Ford, Powell and Carson
San Antonio, Texas
George S. Hellmuth, A.I.A., Hellmuth, Obata, and Kassabaum
St. Louis, Missouri
Neal T. Lacey, Jr., A.I.A., Pierce and Lacy
Dallas, Texas
Thomas L. McKittrick, A.I.A., McKittrick, Drennan, Richardson and Wallace
Houston, Texas
John Lyon Reid, F.A.I.A.
San Francisco, California
Frank D. Welch, A.I.A.
Midland, Texas
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

G. Grenfell Baines, F.R.I.B.A., Building Design Partnership
Manchester, England
Jonathan Barnett, A.I.A., New York City Planning Commission
New York, New York
E. C. Bassett, A.I.A., Skidmore, Owings and Merrill
San Francisco, California
Benjamin E. Brewer, A.I.A., Neuhaus and Taylor
Houston, Texas

William Chafee, A.I.A., Urban Development Corporation
New York, New York
David A. Crane, Architect
Philadelphia, Pennsylvania
Peter D. Eisenman, A.I.A., The Institute for Architecture and Urban Studies
New York, New York
O'Neil Ford, F.A.I.A., Ford, Powell and Carson
San Antonio, Texas
William J. Geddis, A.I.A., The Architects Collaborative, Inc.
Cambridge, Massachusetts
Romaldo Giurgola, A.I.A., Mitchell/Giurgola Associates
Philadelphia, Pennsylvania
James Haecker, A.I.A., National Bureau of Standards, Building Research Division
Washington, D.C.
E. G. Hamilton, F.A.I.A., Harrell and Hamilton
Dallas, Texas
Jorg Herkommer
Stuttgart, Germany
Norman Hoover, A.I.A., Caudill, Rowlett, Scott
New York, New York
Guillermo Jullian, Atelier Jullian
Paris, France
Louis I. Kahn, F.A.I.A.
Philadelphia, Pennsylvania
Neal Mitchell, Jr.
Cambridge, Massachusetts
S. I. Morris, F.A.I.A., Wilson, Morris, Crain and Anderson
Houston, Texas
W. C. Muchow, A.I.A., Muchow Associates
Denver, Colorado
Walter A. Netsch, Jr., F.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
Cesar Pelli, A.I.A., Gruen Associates
Los Angeles, California
John M. Rowlett, F.A.I.A., Caudill, Rowlett, Scott
Houston, Texas
Kevin Roche, A.I.A., Kevin Roche, John Dinkeloo and Associates
Hamden, Connecticut
William Slayton, The American Institute of Architects
Washington, D.C.

Gene R. Summers, A.I.A., C. F. Murphy Associates
Chicago, Illinois
Henry Wood, A.I.A., Kallmann and McKinnell
Boston, Massachusetts

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. Acquisition of understanding and skill in the manipulation of this expression for contemporary urban society is the work of the School of Architecture at Rice University. Houston is the case study.

Four degrees are offered: Bachelor of Arts, Bachelor of Architecture, Master of Architecture, and Master of Architecture in Urban Design. After successful completion of the first four years of study, the Bachelor of Arts degree is awarded. At this time the candidate's work is evaluated before he is admitted to graduate work leading to the professional degree of Bachelor of Architecture.

Undergraduate Program In Architecture. The first two years of the architectural curriculum comprise a carefully integrated study of the principles of architecture. The work of both years is coordinated by a senior professor, bringing together the assembled values and abilities of the faculty of architecture.

Self-determination underscores the second two years of the architectural curriculum. Each student is encouraged, with the assistance of faculty counsel, to develop his own interests and capacities through an individual set of seminars, studio projects, and interdisciplinary courses.

Supplementing the regular academic instruction are several auxiliary programs designed to span the gap between school and practice: the Preceptorship Programs, the visiting lecturer series, and the visiting critic series. The Preceptorship programs are designed to bridge classroom studio learning and professional practice. Under the programs, qualified 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 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 architectural study at Rice.

Also, the school 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. 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 programs leading to the

Bachelor of Architecture and the Master of Architecture degrees are concerned with the design of the total physical environment. The scope of investigation, study, and design may involve the broadest aspects of regional and urban design as well as the more particular design of specialized building types, technology, furniture and artifacts.

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 501a, 502b, 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 both a class and an individual 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.

The normal residence period for the Master of Architecture is two years for those candidates holding Bachelor degrees with a major in architecture, and one year for candidates already holding the professional degree in architecture. Each candidate is assigned a faculty member as advisor to his course of study, and as his thesis director. Candidates holding a first degree in a field other than architecture will be admitted on a limited basis to a Special Student category. Programs will be individually arranged, leading to a Master of Architecture degree.

Graduate Program In Urban Design. For students particularly interested in problems of the urban environment, a two-year program awarding the degree Master of Architecture in Urban Design is offered. A professional degree in Architecture is the prerequisite to this program.

Large-scale urbanization and rebuilding in cities requires designing at one point in time major segments of the city, a process which taxes traditional architectural techniques. Urban Design links the architectural concerns of designing individual buildings or complexes with those two-dimensional concerns of the city planner for land use and transportation plans. The urban designer must find means for coordination of public and private sectors in the building or rebuilding process, and must have a background in behavioral sciences, in political science, and in economics.

The concern of the urban designer is to provide a physical structure and plan for appropriate segments of the city, in response to the recognized needs as well as the aspirations of the city dweller.

The development of Houston is typically that of an American city as altered by the advent of the automobile as a generator of urban form.

It is the intent to use Houston as a case study in investigations to understand the nature of what urbanism is and might be in this kind of city, to understand why development has taken place as it has, and to research this in depth. The context of the program will be set in an interdisciplinary fashion in which the social and behavioral sciences play a major part in the program.

The aspect of effectuation is a major concern, and this should be part of the design process. This emphasizes the concern in solving today's problems today so as not to restrict tomorrow. It is necessary in terms of effective transmittal of these kinds of ideas to develop new tools for communications, and frequently one must communicate the idea of process in lieu of form. Exploration in this kind of activity is a part of the program.

Each candidate will be enrolled in Architecture 603a, 604b, and 703a, 704b in the School of Architecture. Two additional courses per semester in the University as prescribed by the Urban Design program will be required.

COURSES

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

Requisite course for major in architecture. Visual studies of restricted dimensions approached through individual explorations using simple tools and materials. Experience in generalizing a pattern or process before specifying its components and variations; investigation of variants within themes, flexibility and freedom within order, random elements within nonrandom structuring; leading the student to a more sensitive awareness of relationships and interrelationships in the world about him. *Miss Evans*

Architecture 201a, 202b. Principles of Architecture II (3-9-6, each sem.).

Requisite course for major in architecture. A systematic approach to architectural design. Laboratory work is a series of problems introducing design as an analytic and synthetic problem-solving process; seminar explores expressive value of space, structure, materials and form; introduction to preliminary computer applications; spring field trip to major cities. Prerequisite: Architecture 101a, 102b. *Mr. Papademetriou*

Architecture 203a, 204b. Structural and Construction Systems (3-0-3, 3-3-4).

Requisite course for major in architecture. An introduction to the characteristics of materials and basic structural analysis; design of wood and masonry structures; field trip to buildings under construction. *Mr. Morehead and Mr. Scott*

Architecture 303a, 304b. Structural Analysis and Design (3-3-4, 3-0-3).

Analysis and design of reinforced concrete and steel members. Laboratory in materials preparation and testing; field trips to selected construction projects. Architecture 304b not offered 1971-72. *Mr. Morehead and Mr. Krahl*

Architecture 305a. Theory and Practice in Urban Design (3-0-3).

Comparative analysis of recent theory and practice in projecting and controlling urban growth and change. *Mr. Mitchell*

Architecture 306b. Dynamics of Urban Development (3-0-3).

Studies in the economic, social, and political pressures that determine the modern city. *Mr. Parsons and Visitors*

Architecture 308b. History and Theory of Urban Form (3-0-3).

Case studies of important historical examples; analysis of the physical form and the influences and forces which affected the development. *Mr. Cannady*

Architecture 309a. Architectural Practice and Management (3-0-3).

A seminar in the problems and potential of architectural practice. Client relations, contract documents, law, insurance, supervision of construction, and management. Not offered 1971-72. *Mr. Ransom and Mr. Dyess*

Architecture 310a. Interior Design, Finishes and Furniture (3-0-3).

A study of contemporary options in the use of materials, furniture, and finishes in interior design. A case study application forms the completion of the course. *Mr. Ransom*

Architecture 312b. Materials Detailing (3-0-3).

Problems in proper selection of materials; structural and weatherproofing connections; maintenance and economy. Not offered 1971-72. *Mr. Scott*

Architecture 313a. Computer Applications and Programming in Architecture (3-0-3).

A seminar in present and potential uses of the electronic computers in architectural programming, graphic display, and program analysis. *Mr. Hendren*

Architecture 314b. Advanced Computer Projects (3-0-3).

Projects in architectural programming, graphic display, and problem analysis. *Mr. Hendren*

Architecture 315a. Environmental Control Systems (3-0-3).

Analysis and design of systems for the provision of thermal, lighting, and acoustic comfort, and of systems for building transport. *Mr. Long*

Architecture 316b. Building Industrialization (3-0-3).

An investigation into the forces, methods, and potential for industrial standardization and prefabrication of building components. Case studies in open and closed construction systems. *Mr. Long*

Architecture 317a. Readings in Design Theory I (3-0-3).

An in-depth investigation of selected issues of the Heroic Period in Modern Architecture (1920-1940) and an analysis of the relationship between theory and creative work. Independent analytical papers form the completion of the course. Prerequisite: Architecture 201a, 202b, History of Art 346b. Limited enrollment. *Mr. Papademetriou*

Architecture 318b. Readings in Design Theory II (3-0-3).

A review of selected readings covering recent attempts at the formulation of a theoretical framework in architectural design. Independent analytical papers form the completion of the course. Prerequisite: Architecture 201a, 202b, History of Art 346b. Limited enrollment. *Mr. Papademetriou*

Architecture 319a. Communications Workshop (2-3-3).

Study of visual perception and experience toward developing sensitivity to space, form, and texture: experimentation in graphic techniques to express experience.
Mr. Schorre

Architecture 320b. Communications Workshop (2-3-3).

Study of visual perception and experience toward developing sensitivity to space, form, and texture: experimentation in graphic techniques to express experience. May be taken as continuation of 319a; however, 319a is not a prerequisite.
Mr. Schorre

Architecture 401a. Studio Projects: Community Structures (3-9-6).

Problems in educational, civic, and commercial design, presented with specific site constraints, and full programmatic development. *Mr. Parsons*

Architecture 402b. Studio Projects: Community Structures (3-9-6).

Problems in educational, civic, and commercial design, presented with specific site constraints, and full programmatic development. *Mr. Parsons*

Architecture 403a, 404b. Advanced Structural Design (3-0-3, each sem.).

Design of complete structural systems for buildings. Choice of structural systems. Optimum structures. Shell, tensile, and space frame structures. Prerequisite: Architecture 303a, 304b. Architecture 404b not offered 1971-72. *Mr. Krahl*

Architecture 405a. Studio Projects: Urban Design (3-9-6).

City form as a contextural prerequisite to significant architectural form. Analysis and synthesis of current and projected problems for specific developments in Houston. *Mr. Scott*

Architecture 406a. Studio Projects: Housing and Related Community Planning (3-9-6).

Studies in the cultural and economic determinants of urban residential form.
Mr. Erdman

Architecture 407a. Studio Projects: Environmental Factors (3-9-6).

Problems in development of architectural spaces as affected by environmental controls: artificial and natural lighting, acoustics, thermal comfort. *Mr. Long*

Architecture 408b. Studio Projects: Architectural Systems (3-9-6).

Design with industrialized building components and sub-systems. *Mr. Long*

Architecture 409a. Studio Projects: Commercial Facilities (3-9-6).

Problems in office and shopping structures. Development of economic models and constraints in commercial programming. Not offered in 1971-72.

Architecture 410b. Studio Projects: Simple Structures (3-9-6).

Design and construction of simple structures dealing in detail with the complete architectural process. *Mr. Scott*

Architecture 411a. Special projects in Architecture (variable credit).

Independent research or design arranged individually in consultation with a faculty member, subject to approval of the Curriculum Committee. Very limited enrollment. *Staff*

Architecture 412b. Special projects in Architecture (variable credit).

Repeat in spring semester of 411a.

Architecture 499a, 499b. Preceptorship B Program (0-0-15).

Cooperative educational program providing one year of professional experience with full academic credit under jurisdiction of university. Preceptors are outstanding architects from firms and organizations of national and international stature; Preceptees submit bi-monthly progress reports. *Preceptors*

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

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

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

Independent investigations in architecture culminating in preparation and presentation of a master's thesis. Laboratory fee required. *Mr. Cannady, Staff Specialists*

Architecture 603a. Principles of Urban Design I (5-15-10).

Analysis of components of urban form and process, definition of problem-solving methodologies, and review of current urban design theories.
Mr. Mitchell, Staff Specialists

Architecture 604b. Principles of Urban Design II (5-15-10).

Development problem testing the methods and theories defined in the fall semester with emphasis on understanding new techniques in generating urban process and form. *Mr. Cannady, Staff Specialists*

Architecture 605a. Real Estate and Development Practices (2-0-2).

The role of private enterprise in urban development.

Architecture 606b. Urban Systems Simulation Techniques (2-0-2).

A study of urban simulation techniques emphasizing computer capability and land use gaming programs. *Mr. Britton*

Architecture 611a. Case Studies in Urban Design (2-0-2).

A detailed analysis of selected recent built projects illustrating urban design problems and solutions. *Mr. Mitchell, Mr. Cannady*

Architecture 621a. Planning Law and Land Development (2-0-2).

A study of government legislation related to effectuation of urban development; a consideration of private response is included. *Mr. Mixon*

Architecture 622b. Planning Law and Land Development (2-0-2).
Continuation of Architecture 621a. *Mr. Mixon*

Architecture 632b. Transportation and Land Use (2-0-2).
A seminar describing supply and demand characteristics of various transportation technologies resulting in differing flow patterns and their impact on land values, location, and intensity of urban activities as well as urban form.

Architecture 633a. Community Facilities Planning (2-0-2).
A study of selected community facilities and how they relate to the urban context. *Mr. Conant*

Architecture 634b. The Federal Role in Urban Affairs (2-0-2).
A study of the changing relationship between the Federal Government and local urban government. *Mr. Conant*

Architecture 635a. Politics of Housing (2-0-2).
A seminar on case studies of FHA housing controversies in Houston and other cities. *Mr. Conant, Staff*

Architecture 636b. Education Project Seminar (2-0-2).
A continuation of the Community Facilities Planning course with an emphasis on the restructuring of public education. *Mr. Conant*

Architecture 637a. Housing (1-0-1).
Housing programs with government support; history limitations and practices.

Architecture 700a. Non-Resident Research

Architecture 700b. Non-Resident Research

Architecture 703a. Principles of Urban Design III (5-15-10)
An urban redevelopment problem testing the methods and theories previously defined. The interrelationship between the public and private sector is emphasized. *Mr. Britton, Staff Specialists*

Architecture 704b. Principles of Urban Design IV (5-15-10).
Independent investigations in Urban Design problems culminating in the preparation and presentation of a master's thesis. *Staff*

Accounting

(*See* pages 168-170)

Art

(*See* pages 213-217)

Anthropology

PROFESSOR TYLER, *Chairman;* PROFESSORS HOLE AND NORBECK
ASSOCIATE PROFESSOR GAMST
ASSISTANT PROFESSORS BLANTON AND PROVENCHER
VISITING ASSISTANT PROFESSOR UZZELL
LECTURER CRESON

The Undergraduate Major in Anthropology. Anthropology is a discipline with many subjects of study, all relating to the understanding of man and his culture. A student may organize a major in one or more of anthropology's principal fields or may combine a major in anthropology with one in another discipline. Students majoring in anthropology should become acquainted with all four of the principal fields of the discipline; ethnology, archeology, linguistics, and physical anthropology. Students majoring in anthropology are required to take a total of ten semester-courses of anthropology. For majors, Anthropology 200, Physical Anthropology, is required; Anthropology 201, Introductory Cultural Anthropology, and Anthropology 203, Introduction to Archeology, are strongly recommended. With the approval of the departmental advisor, a maximum of two semester-courses numbered 300 or higher in related subjects, including certain courses in biology, history, and the social sciences may be substituted for courses in anthropology. Within the general requirements, the program of each student majoring in Anthropology is planned to meet individual interests and plans for future careers. Anthropology 400 will ordinarily be taken by all majors who intend to pursue graduate study in anthropology. Majors who plan to pursue professional careers in anthropology will need during graduate training a reading knowledge of one or two European languages, and in preparation are urged to enroll in undergraduate classes in languages.

Graduate Work in Anthropology. The Doctor of Philosophy in Behavioral Science with a major in Anthropology is offered under an interdisciplinary program. See Behavioral Science.

COURSES

(*See* also courses in Behavioral Sciences)

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

Human evolution, fossil man, human genetics, races of man and problems of race; the beginnings of culture. Two class lectures and one section meeting weekly.
Mr. Blanton

Anthropology 201a. 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 203a. Introduction to Archeology (3-0-3).

Introduction to the principles and methods of archeological research. Survey of prehistoric cultures in the Eastern and Western hemispheres from the origin of culture to the rise of civilizations. *Mr. Blanton*

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 technology, 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. Prerequisite: Anthropology 201 or Anthropology 333, or with permission of the Instructor, the equivalent of one of these courses. *Mr. Norbeck*

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

A survey of selected non-Western societies which illustrate varying modes of adaptation to geographical and cultural environments. *Mr. Uzzell*

Anthropology 311a. 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. *Mr. Blanton*

Anthropology 313a. Language and Culture (3-0-3).

Investigates the systematic relations between linguistic form and expression and culture. No prerequisite. *Mr. Tyler*

Anthropology 319a. Old World Prehistory (3-0-3).

The origin and development of human culture during the Pleistocene period. *Mr. Hole*

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

The origins, development and spread of food production; and the beginning of literate civilization in the Near East. *Mr. Hole*

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

Man's entry into the Americas; his dispersal and varied ecological adaptations; the development of these cultures to the rise of food-producing and the beginning of village life. Not offered in 1971-72.

Anthropology 322b. New World Prehistory (3-0-3).

The evolution of the New World civilizations, in Mesoamerica and the Central Andes, to the Spanish conquest. Not offered in 1971-72.

Anthropology 323a. Archeological Techniques (2-4-4).

An introduction to archeological theory as it relates to excavation; the principal techniques used in field work, laboratory analysis of artifacts and interpretation of archeological data. Basic techniques of topographic mapping, excavation, photography, recording and processing of artifacts will be taught in the context of an excavation project in which students will participate on weekends. There will be approximately 8 days of excavation and a weekly 2 hour class in which lectures and demonstrations are presented. Students will also schedule laboratory time to work on the material they excavate. Each student will prepare a report on his part of the project. Prerequisite, one of the following: Anthropology 203, 319, 320, 321, 322. *Mr. Hole*

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

A survey of native and European cultures of Latin America, including historical backgrounds and modern problems. *Mr. Uzzell*

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

The growth and characteristics of civilization in Mesopotamia, Egypt, India, Mesoamerica, and Peru are examined historically and comparatively. *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 1971-72.

Anthropology 333a. The Nature of Culture (3-0-3).

An introductory course in anthropology designed especially for juniors and seniors but open also to freshman and sophomores who wish to enroll in an upper division course covering the field of anthropology in general that gives major emphasis to cultural and social anthropology. The course covers major aspects of culture and subjects of anthropological concern, and also principal viewpoints of anthropology and approaches to gaining an understanding of man and his culture. Not open to students who have taken Anthropology 201a, Introductory Cultural Anthropology. *Mr. Norbeck*

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

Ethnological survey of the development and distribution of Old World peasantries and study of representative modern groups emphasizing rural urban relations and cultural dynamics. Not offered in 1971-72.

Anthropology 350b. 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. *Mr. Gamst*

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

Ethnology of Africa, emphasizing the peoples and cultures of sub-Saharan Africa. Not offered in 1971-72.

Anthropology 353a. Cultures of India (3-0-3).

Summary of the pre-history, ethnography, and ethnology of the Indian subcontinent. Special emphasis will be given to ideology and social organization. Not offered in 1971-72.

Anthropology 356b. Cultures of Southeast Asia (3-0-3).

A survey of ancient, traditional and modern cultures of mainland Southeast Asia, the Malay Peninsula, Indonesia and the Philippine Islands with emphasis on the historical, environmental and social structural factors contributing to the development of modern problems. Not offered in 1971-72.

Anthropology 360b. 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. *Mr. Creson*

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. Not offered in 1971-72.

Anthropology 381a. 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. *Mr. Uzzell*

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. Not offered in 1971-72.

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. Not offered in 1971-72.

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. *Mr. Norbeck*

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. *Mr. Uzzell*

Anthropology 402b. Cultural Ecology (3-0-3).

A discussion of theoretical and methodological approaches to the analysis of systemic relationships among environmental, demographic, and sociocultural variables. Special emphasis will be placed on the study of culture change. *Mr. Blanton*

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 406b. Cognitive Anthropology (3-0-3).

Focuses on the relations between thought, language, and culture. Special emphasis will be given to systems of folk classification and the logical principles underlying them. Permission of instructor is required for enrollment. *Mr. Tyler*

Anthropology 410b. Archeological Analysis (3-0-3).

An advanced tutorial course in which students will analyze materials derived from research projects directed by the staff or, in some instances, carried out and directed by the students. Students will prepare a technical manuscript dealing with their analyses and a study of comparative material from archeological reports. Prerequisite: Archeological Techniques and approval of instructor. *Mr. Hole*

Anthropology 506b. Ethnological Research Methods (3-0-3).

A seminar devoted to consideration and use of field techniques and other re-research methods in ethnology. Open to seniors in anthropology with consent of instructor. *Mr. Gamst*

Anthropology 508b. Linguistic Anthropology (3-0-3).

Devoted to the application of linguistic theory and method in the analysis of cultural materials. Permission of instructor is required for enrollment. *Mr. Tyler*

Anthropology 510b. Current Topics and Problems in Anthropology (3-0-3).

Advanced seminar in anthropology dealing with anthropological topics and problems of special prominence and interest, including major new subjects of investigation. Open to graduate students and, with permission of the instructor, to seniors majoring in Anthropology and Behavioral Science who have completed Anthropology 400, Ethnological Theory. *Mr. Norbeck*

Behavioral Science

Undergraduate Program. The major in behavioral science centers on a nucleus of courses in anthropology, psychology, and sociology. The student will ordinarily, but not necessarily, 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 minimum of ten semester-courses in anthropology, psychology, and sociology, of which eight ordinarily must 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. If desired, two semesters at the 200 or introductory level may be substituted for advanced level courses, if in a field of the major in which no courses have been taken previously.

Graduate Program. The departments of Anthropology and Sociology offer an interdisciplinary graduate program in Behavioral Science leading to the doctorate with specialization in either anthropology or sociology. Students specializing in one of these fields are required to have introductory training in the other field (anthropology or sociology) and also in psychology. This requirement may be met by providing evidence of satisfactory completion of two or more courses (at least 6 semester hours) in these fields at the undergraduate or graduate level, at Rice University or other accredited institutions, before or after admission to the graduate program. A Qualifying Examination testing knowledge in sociology or anthropology, dependent upon the student's field of specialization, must be taken at the end of the first year and must be passed not later than the end of the second year. Comprehensive examinations in the field of specialization (anthropology or sociology) must be passed before the student is admitted to candidacy for the Ph.D. and undertakes work on the doctoral dissertation. Many courses given in Anthropology, Sociology, as well as those bearing the title Behavioral Science may be taken by students specializing in either field, and the program of each student is individually planned to take as much advantage as possible of the interdisciplinary training while still gaining competence in the field of specialization. No competence in a foreign language is required of majors in sociology; competence in one foreign language is ordinarily required of majors in anthropology.

An important part of the student's training is participation in research and teaching. Each student will have an individual advisor and will ordinarily participate in research programs directed by the advisor and participate also in the activities of undergraduate and graduate teaching, including the giving of class instruction and the grading of examinations. Upon completion of the comprehensive examinations and approval of candidacy for the Ph.D., the M.A. is optionally offered, but no students who intend to complete only the M.A. are admitted to the program. The M.A. as a terminal degree will be awarded only in unusual cases. In such cases, the M.A. will require satisfactory completion of 30 hours of course work approved by an advisor, a passing grade in the qualifying examination in the candidate's field of concentration and a thesis.

Additional information on the curricula of study in sociology and anthropology, which differ somewhat in details, may be obtained from the departments of Anthropology and Sociology.

BEHAVIORAL SCIENCE COURSES

Behavioral Science 500a. Social Thought and Social Theory (3-0-3).

Critique and analysis of theories of social organization developed by several major social scientists. *Mr. Lambert*

Behavioral Science 505a, b. Independent Study and Tutorial (0-0-3 to 9).

Staff

Behavioral Science 506b. Ethnological Research Methods (3-0-3).

A seminar devoted to consideration and use of field techniques and other research methods in ethnology. Open to seniors in anthropology with consent of instructor. *Mr. Gamst*

Behavioral Science 509a. 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*

Behavioral Science 510b. Current Topics and Problems in Anthropology (3-0-3).

Advanced seminar in anthropology dealing with anthropological topics and problems of special prominence and interest, including major new subjects of investigation. Open to graduate students and, with permission of the instructor, to seniors majoring in Anthropology and Behavioral Science who have completed Anthropology 400, Ethnological Theory. *Mr. Norbeck*

Behavioral Science 515a. 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. *Mr. Norbeck*

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

A study of the characteristics of traditional societies. *Mr. Hudson*

Behavioral Science 520b. Quantitative Techniques (3-0-3).

An introduction to the statistical methods used in the analysis of data. *Mrs. Sheldon*

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

A study of characteristics of developing societies. *Mr. Hudson*

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

Examination of the major objectives, strategies and tactics of behavioral science research, combined with practical experience in conducting an interdisciplinary empirical project. The focus will be on conceptualization, theoretical formulation of research questions, operationalization, and evaluation of research designs and instruments. The course is open to selected undergraduates with approval of the instructor. Not offered in 1971-72.

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

Examination of the major objectives, strategies and tactics of behavioral science research, combined with practical experience in conducting an interdisciplinary empirical project. Concentration will be on data collection and processing procedures, multivariate statistical analysis, and principles of theoretical inference. Laboratory sessions and field work will provide direct experience with statistical computation, computer usage, observation and interviewing. The course is open to selected undergraduates with approval of the instructor. Each student will prepare a paper of journal article length giving a completed analysis and interpretation of some of the project data, in a form suitable for publication. *Mr. Gordon*

Behavioral Science 546b. Linguistic Anthropology (3-0-3).

Devoted to the application of linguistic theory and method in the analysis of cultural materials. Permission of instructor is required for enrollment. *Mr. Tyler*

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

Seminar devoted to research concerned with ecological and cultural influences in urban areas. Not offered in 1971-72.

Behavioral Science 598a. Research and Thesis in Behavioral Science. (0-0-3 to 9).

Staff

Behavioral Science 599b. Research and Thesis in Behavioral Science. (0-0-3 to 9).

Staff

Behavioral Science 698a. Research and Thesis in Behavioral Science. (0-0-3 to 9).

Staff

Behavioral Science 699b. Research and Thesis in Behavioral Science. (0-0-3 to 9).

Behavioral Science 700. Non-resident Research.

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

Houston Inter-University African Studies Program

By arrangement in the field of African Studies among the University of St. Thomas, the University of Houston, Texas Southern University, and Rice University, students at these universities with an interest in African studies may attend and obtain credit for certain courses on Africa given at any of these universities. Information on the Inter-University Program and its courses can be obtained from the Rice University representative of the program, Mr. Gamst.

Biology

Professor Subtelny, *Chairman;* Professors Awapara, Campbell, Philpott, Read, Storck, J. B. Walker and C. H. Ward
Associate Professors F. Fisher and Ansevin
Assistant Professors Bruner, Eisenberg, Glantz, Hammond, Johnson and Stewart
Lecturers Hake and Pulley

Undergraduate Program. Biology majors are required to take introductory courses in physics and mathematics, Chemistry 120a, Organic Chemistry, and Biology 101a, 102b. Students majoring in Biology must take ten semester courses in Biology. Eight of these courses must be in the advanced level and four of the eight must be accompanied by a laboratory. Students desiring a double major including Biology must take six advanced courses and four laboratories. All majors must complete Biology 101a, 102b, with laboratory as well as Biology 303a and 316b. The latter two requirements are counted in the eight advanced courses.

Biochemistry Major. The Biochemistry Program is administered by a Biochemistry Committee made up of faculty members of the Biology and Chemistry Departments. The Biochemistry major must have fourteen advanced level courses (numbered 300 or higher) out of a total of forty courses to obtain the Bachelor of Arts degree.

In addition to a reasonable distribution of electives, the Biochemistry major must take the following specific courses.

Freshman level:	Math. 101a, 102b; Chem. 101a, 102b; Phys. 100a, b, and 130b.
Sophomore level:	Math. 201a, 202b or 205a, 206b; Chem. 210a, 210b; Phys. 210a, b and 230a.
Advanced level:	Chem. 310a, b, and 311a; Chem. 400a; Biol. 303a, 460b, and 304a; three additional advanced biology courses (can include Biol. 400a).

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 400 for one advanced semester-course during the Senior year. An additional semester of Biology 400 may be taken as an elective during the second semester of the Senior year and can fulfill one of the four laboratory requirements. Students may also take one 500 level course that can be used to fulfill one of the eight advanced elective rquirements. He may not, however, use Biol. 400 and a 500 level course to fulfill two of the advanced elective requirements. Funds are 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. Prospective graduate students must take the Graduate Record Examination. The entering graduate student generally is expected to have a strong background in one of the several areas of biology; in addition completion of courses in physics (1 year), mathematics (including calculus), and chemistry (including organic) is required. The above requirements do not preclude admission of qualified applicants who have majored in areas other than Biology. Any deficiencies must be made up no later than the first year of residence in the Graduate School, including the first summer. It is strongly recommended that deficiencies be made up during the summer preceding the first semester of residence.

Program for the Degree of Doctor of Philosophy:

(a) Complete three or more years of graduate study with at least the last two years at Rice University.
(b) Complete an original investigation worthy of publication in a scientific journal, and the submission of a doctoral thesis as described in the General Announcements.
(c) Maintain a grade point average of 2 or better in courses taken in the department and satisfactory grades in courses taken outside of the department.
(d) Perform satisfactorily as a teaching assistant for at least four semesters.
(e) Pass a comprehensive preliminary examination administered by the advisory committee. This examination may be oral and/or written.
(f) Defend publicly his thesis.
(g) Present a Departmental Seminar on his research.

Program for the Degree of Master of Arts:

The degree of Master of Arts may be obtained after the completion of 30 hours of graduate study, 6 hours of which must be earned by the completion and public defense of a thesis embodying the results of an original investigation.

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 for at least two years regardless of appointment.

COURSES

Biology 101a, 102b. Introduction to Biology (3-3-4, each sem.).

A general introductory course dealing with the basic principles of biology. The laboratory work will include demonstrations and selected experiments. *Staff*

Biology 301a. Animal Biology (3-0-3).

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 and terrestrial habitats. Prerequisite: Biology 101a, 102b. *Messrs. Fisher and Hammond*

Biology 302a. Laboratory in Animal Biology (0-3-1).

Laboratory exercises are designed to introduce the student to functional morphology as it applies to the invertebrates and vertebrates. Prerequisite: Consent of instructor. *Messrs. Fisher and Hammond*

Biology 303a, b. 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: Chemistry 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. *Mr. Awapara*

Biology 305b. General Physiology (3-0-3).

Analysis of cellular functions with emphasis on transport, excitable membranes, contractile processes, energy coupling and the relation of these processes to biologic ultrastructure. Prerequisites: Chemistry 200a, b, Biology 101a, b, 303a, and General Physics. *Mr. Glantz*

Biology 306b. Laboratory for General Physiology (0-3-1).

Limited to 40 students. *Mr. Glantz*

Biology 307a. Developmental Biology (3-0-3).

An analysis of processes and principles in development of organisms with emphasis on experimental embryology. Recommended concurrent registration in Biology 303a. *Mrs. Ansevin*

Biology 308a. Ecology (3-3-4).

A study of the interrelationships of organisms and their environment. The lab will consist of field trips to study nearby habitats. Prerequisite: Biology 101a,b or consent of instructor. *Mr. Johnson*

Biology 309b. Population Ecology (3-0-3).

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. Prerequisite: at least three semester courses in Biology. *Mr. Eisenberg*

Biology 310b. Laboratory in Population Ecology (0-3-1).

Students will select and pursue individual projects involving the manipulation of laboratory or field populations. Project reports will be required. Prerequisites: Registration for Biology 309b and consent of instuctor. *Mr. Eisenberg*

Biology 315a. Botany (3-3-4).

A comparative study of plants as viewed through physiology and evolution. Prerequisite: Biology 101a, b. *Mr. Pulley*

Biology 316b. Genetics (3-0-3).

An analysis of the structure, function, and transmission of the genetic material, from both the classical and molecular points of view. Emphasis is placed on the use of microbial systems and biochemical techniques for the elucidation of genetic mechanisms. Required for Biology majors. It is recommended, but not required, that Biology 303a be taken first. *Mr. Stewart*

Biology 317b. Genetics Laboratory (0-3-1).

An introduction to laboratory research in genetics. Should be taken concurrently with Biology 316b. *Mr. Stewart*

Biology 400a, b. Special Problems and Honors Work (2-6-4, each sem.).

Open only to Senior biology majors and with permission of an instructor in charge of the project and the chairman of the department. For use primarily in honors programs. Only one semester of Biology 400 may be substituted for advanced biology courses during the senior year. *Staff*

Biology 405b. Plant Physiology (3-0-3).

The cellular and organismal physiology of selected plant types. Attention will be given to nutrition, metabolism, growth, and physiological interactions with environment. Prerequisite: Biology 303a. *Mr. Ward*

Biology 406b. Laboratory in Plant Physiology (0-3-1).

Mr. Ward

Biology 409b. Cellular and Molecular Aspects of Development (3-0-3).

Discussions of mechanisms of information transfer and their controls in development. Analysis of determination and differentiation of cell phenotypes. Prerequisites: Biology 307a and 316b. *Mr. Subtelny*

Biology 410b. Laboratory for Developmental Biology (0-6-1).

The laboratory work will concern observation and experimental analysis of development mainly in amphibian and avian embryos. Lab. fee required. Eight students per lab section. Prerequisites: Biology 307a or consent of instructor. *Mr. Subtelny*

Biology 411a. Microbiology (3-0-3).

A study of the anatomy, physiology and molecular biology of procaryotic and eucaryotic microbes, and viruses. Saprophytic and pathogenic forms will be discussed. Prerequisites: Biology 303a and 316b or consent of instructor. *Mr. Storck*

Biology 412a. Laboratory in Microbiology (0-3-1).

Isolation and characterization of representatives of the major groups of microbes. Quantitative studies of the physiology of some microbial forms. Limited enrollment. *Mr. Storck*

Biology 420a. Parasitism and Symbiosis (3-3-4).

An introduction to the biology of symbiosis, with special emphasis on parasitism. Major attention will be given to the physical and chemical relationships between organisms. Examples illustrating principles are drawn from viral, bacterial, fungal, protozoan and helminth symbiotes living in association with plant and animal hosts. Prerequisite: Biology 303. *Mr. Read*

Biology 435b. 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. *Mr. Pulley*

Biology 440b. Comparative Biochemistry (3-0-3).

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. Prerequisite: Biology 303a. *Mr. Campbell*

Biology 445a. Comparative Vertebrate Physiology (3-0-3).

Studies of the physiology of organ systems. Homeostatic capacities of individual systems with their comparative function in various vertebrate groups will be emphasized. Prerequisites: Biology 301a, 302a or consent of instructor. *Mr. Hammond*

Biology 446a. Laboratory in Comparative Vertebrate Physiology (0-3-1).
Mr. Hammond

Biology 460b. Advanced Biochemistry (3-0-3).

A detailed study of the integrated networks of enzymatic reaction 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 (0-8-2).

A laboratory course emphasizing study of individual and coupled enzymatic reactions. Enzyme-catalyzed transfers of phosphoryl groups, amidino groups and hydride ions are studied, utilizing spectrophotometric and radioactive tracer assays. Individual projects are undertaken in the last part of the course. *Mr. Walker*

Biology 475a. Cells and Tissues (3-0-3).

Study of the morphology and functions of cell components, cells and tissues, as revealed by light and electron microscopy and associated histo- and cytochemical methods. Prerequisite: Biology 303a, 305b. *Mr. Philpott*

Biology 476a. Cells and Tissues Laboratory (0-3-1).

Laboratory work in histology and histochemistry and other selected methods for studying cells and tissue. Prerequisite: consent of instructor. *Mr. Philpott*

Biology 478b. Molecular Genetics (3-0-3).

The molecular interactions involved in the operation of the genetic apparatus, including the control mechanisms which regulate the time and extent of gene function. The relevance of the vast (but incomplete) body of knowledge about the bacterium *Escherichia coli* and its viruses to high organisms will be critically considered. In addition to the series of lectures, there will be small section meetings at which students will lead discussions of classical and current research papers. Prerequisites: Biology 303 and 316b. Biology 307a and 411a will be helpful, but not essential. *Mr. Bruner*

Biology 500a,b. Biology Seminar.

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 509a, b. Biology of Nucleic Acids (3-0-3).

Students will give seminars analyzing recent research in areas such as regulation of gene function and replication of nucleic acids. *Mr. Bruner*

Biology 510a. Topics in Biochemistry (3-0-3).

A seminar with student participation which is concerned with aspects of enzymatic catalysis. 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 520a, b. Advanced Cell Physiology (3-0-3).

A seminar on current literature and research in cell physiology and cellular metabolism. Offered in alternate years with Biology 521. Prerequisite: Biology 460b or equivalent. The topic for 1971-72 will be mitochondrial ammonia metabolism.
Mr. Campbell

Biology 521. Advanced Comparative Biochemistry (3-0-3). (3-0-3).

A seminar on current literature and research in comparative biochemistry and biochemical evolution. Offered in alternate years with Biology 520. Prerequisites: Biology 440a, or equivalent. *Mr. Campbell*

Biology 525a. Concepts of Nervous System Functions (3-3-4).

An examination of the nervous system in terms of information processing and regulatory mechanisms. Prerequisite: Biology 305b or an equivalent and consent of instructor. Understanding of basic neuromuscular and synaptic physiology is assumed. Limited to 15 students. *Mr. Glantz*

Biology 540b. 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, 475a, 476a.
Mr. Philpott

Biology 541b. Topics in Cell Biology (3-0-3).

Mr. Philpott

Biology 542a. Special Projects in Developmental Biology (0-6-2).

Laboratory designed to give training in experimental manipulations on developing eggs and embryos; individual research projects. Given on demand.
Mrs. Ansevin

Biology 543b. Cell and Tissue Interactions in Development (3-0-3).

Seminar course surveying recent literature on the subject. Prerequisites: Biology 303 and 307a; 409b is recommended.

Biology 547. Advanced Developmental Biology (3-0-3).

Lectures, informal seminars and reports with direct student participation on recent advances in problems of embryonic development. Prerequisite: Biology 307a and 303; 409b is recommended. *Mr. Subtelny*

Biology 550a, b. Topics in Microbiology (3-0-3).

Discussion of research literature. *Mr. Storck*

Biology 552a, b. Topics in Plant Biology (3-0-3).

A seminar on current literature and research in plant biology. Prerequisite: Consent of instructor. *Mr. Ward*

Biology 560a, b. Physiology of Parasitism (3-0-3).

Conferences, students 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 physical and chemical problems with examples drawn from the animal or plant kingdom. *Mr. Read*

Biology 561a, b. Topics in Symbiology (3-0-3).

Mr. Read

Biology 562a, b. Marshland and Estuarine Biology (1-6-3).

Emphasis will be directed toward the value of these wetlands as a natural resource. Attention will be placed upon student reports, conferences, and field work on the physical environment and the biota of these coastal areas. *Mr. Fisher*

Biology 565a, b. Topics in Population Biology (3-0-3).

Special areas and current advances in population ecology will be covered in depth. Prerequisites: Biology 309b and consent of instructor. *Mr. Eisenberg*

Biology 570b. 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 571b. Invertebrate Endocrinology (3-0-3).

Consideration of current literature dealing with endocrine mechanisms in invertebrates. *Mr. Fisher*

Biology 582b. Advanced Environmental Physiology (3-0-3).

Student seminars and projects with special emphasis on the physiological and environmental distribution of selected heavy metals. *Mr. Hammond*

Biology 599a, b. Topics in Microbial Genetics (3-0-3).

Students will give seminars analyzing recent research on a subject of current interest in microbial genetics and molecular biology. In 1970, the subject will be mechanisms of genetic exchange. *Mr. Stewart*

Biology 600a, b. Graduate Research.

Biology 700a, b. Thesis Research.
Biology 800a, b. Non-Resident Research.

Chemical Engineering

(*See* pages 176-180)

Chemistry

PROFESSOR MARGRAVE, *Chairman;* PROFESSORS CURL, FRANKLIN, HACKERMAN, KILPATRICK, LEWIS, RICHTER, ROSSINI, SASS AND TURNER
ASSOCIATE PROFESSORS BROOKS, GLASS, HAYES AND STEVENS
ASSISTANT PROFESSORS BILLUPS, ENGEL AND GANSOW

The Undergraduate Program. Undergraduates electing chemistry as a major are expected to satisfy the requirements of the science-engineering program set forth on pages 64-65. In general they will take Chemistry 210a,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 and Chemistry 311a,b
Chemistry 400a and Chemistry 401a
Chemistry 460b
Mathematics 300a,b or any approved two-semester sequence of 300 or higher level courses in Mathematics of Mathematical Science

Senior Year

Two semesters of approver advanced course work in chemistry.

Superior students may substitute undergraduate thesis research (Chemistry 490a, b) for one or two semesters of classroom instruction.

For a major in Chemistry which would be accredited by the American Chemical Society, two years of German and two additional courses in advanced chemistry are required.

Interdepartmental Majors. Interdepartmental majors are offered in biochemistry, chemical physics, and materials science by the Department of Chemistry in conjunction with the Departments of Biology, Physics, or Materials Science, respectively. Students electing one of these majors should discuss their program with both 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

111). 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 signifcant 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 101a, b. Introductory and Analytical Chemistry (3-0-3).

A general introductory course consisting of lecture and discussion sessions, dealing with the basic phenomena and principles of chemistry. This course is normally accompanied by a laboratory sequence, Chemistry 103a, 104b. Both Chemistry 101a, 102b and 103a, 104b (or the equivalent) are required of students who wish to take advanced courses in chemistry. Prerequisite: High school chemistry.

Chemistry 103a, b. Introductory and Analytical Chemistry Laboratory (0-4-1).

An introductory course including volumetric and gravimetric methods of quantitative analysis as well as the fundamentals and methods of qualitative analysis applied to problems of current interest. This course is normally taken concurrently with Chemistry 101a,b. Both Chemistry 101a, 102b and 103a, 104b (or their equivalent) are required of students who wish to take advanced courses in chemistry.

Chemistry 200a, b. Organic Chemistry (3-0-3, each sem.).

Survey of bonding in organic molecules with relation to their stereochemical properties and their reaction mechanisms. A general comprehensive review of the aliphatic and aromatic series, together with the theoretical interpretations relating to their structure and reactions. Whenever possible emphasis will be given to substances of biological and medical interest. This course is designed to fill the needs of students of biology and medicine. Prerequisites: Chemistry 100a,b and Chemistry 101a,b (or their equivalent).

Chemistry 210a, b. Principles of Organic Chemistry (3-4-4, each sem.).

This course is designed to give a thorough survey of aliphatic and aromatic chemistry. Emphasis is on the theories and principles relating bonding, molecular structures and reaction mechanisms. Especially recommended for majors in chemistry, biochemistry, chemical physics and other fields for which further organic courses are expected. Prerequisites: Chemistry 100a,b and Chemistry 101a,b (or equivalent).

Chemistry 300a. Survey of Physical Chemistry (3-0-3).

An introduction to various areas of theoretical and physical chemistry intended for biologists, pre-medical and others not planning to major in chemistry, chemical engineering, biochemistry or closely related fields. Special emphasis will be given to thermodynamic concepts, electro-chemistry, and the theory of solution. Prerequisites: 1 year of calculus; Chemistry 100a,b and Chemistry 101a,b (or equivalent).

Chemistry 310a, b. Physical Chemistry (3-0-3, 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. Prerequisites: Mathematics 200a,b and Physics 100a,b (Physics 210a,b recommended); Chemistry 100a,b and Chemistry 101a,b (or equivalent).

Chemistry 311a. Physical Chemistry Laboratory (0-4-1).

A laboratory course designed to accompany Chemistry 310a.

Chemistry 311b. Advanced Physical, Inorganic and Instrumental Methods Laboratory (0-8-2).

A laboratory course required for junior chemistry majors. Special emphasis will be given to the principles and application of modern instumental methods in the areas of inorganic and physical chemistry. Prerequisites: Chemistry 310a and Chemistry 311a.

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 415a. Chemical Kinetics (3-0-3).

Introduction to reaction kinetics including methods of measurement and phenomenological treatment of simple and chain reactions. Application of kinetic theory of gasses to reaction rates. Transition state theory. Prerequisite: Chemistry 310a,b (or its equivalent).

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 460b. Inorganic Chemistry (3-0-3).

An introduction to the concepts of modern inorganic chemistry, including a treatment of atomic and molecular structures; bonding in covalent, ionic and electron deficient systems; thermochemical principles; and of various experimental techniques for analysis, structure determination and synthesis as applied to inorganic systems.

Chemistry 470b. Methods and Theory of Spectral Analysis (3-0-3).

An introduction to the theory and applications of ultra-violet, infrared, nuclear magnetic resonance and electron spin resonance spectra.

Chemistry 480. Chemistry of Natural Products (3-0-3).

A study of important types of naturally occuring 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. Written thesis and laboratory fee required.

Chemistry 496a. Transition Metal Chemistry (3-0-3).

Topics include mechanisms of inorganic reactions, group theory applications to chemistry, ligand field theory, coordination chemistry. Particular topics will be announced prior to each term. Prerequisite: Chemistry 310a,b.

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-year 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.

Chemistry 515b. Advanced Chemical Kinetics (3-0-3).

Special topics in reaction kinetics including molecular beams, unimolecular rate theory, flames and explosions, ion-molecule reactions, surface reactions, catalysis, electrode processes, and enzyme kinetics. Prerequisite: Chemistry 415a (or its quivalent).

Chemistry 531a. Fundamentals of Mass Spectrometry (3-0-3).

Introduction to mass spectrometry, instrumentation, ionization cross-sections and efficiency curves, Franck-Condon principle, ionization potentials, appearance potentials and heats of formation, simple mass spectra, fragmentation mechanisms, and quasi-equilibrium theory. Not offered in 1971-72.

Chemistry 531b. Advanced Organic Mass Spectrometry (3-0-3).

The mass spectra of complex organic molecules, GLC-mass spectrometer hookups, applications to biochemistry, applications to organic geochemistry and computerized data reduction systems. Prerequisite: Chemistry 531a. Not offered in 1971-72.

Chemistry 532a. Chemistry of Ions in the Gas Phase (3-0-3).

Heats of formation, bond-strength determinations, negative ions, photo-ionization, ion-molecule reactions, chemical ionization, charge exchange, mass spectra. Prerequisite: 531a.

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.

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, Materials Science 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, Materials Science 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 dielecric 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, Materials Science 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, Materials Science 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 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 of organic chemistry. Prerequisite: Chemistry 400a. Not offered in 1971-72.

Chemistry 580a. Special Topics in Alkaloid Chemistry (3-0-3).

A consideration of the chemistry of selected groups of alkaloids.

Chemistry 590a, b. Advanced Topics in Physical and Theoretical Chemistry (3-0-3, each sem.).

Chemistry 596a, b. Special Topics in Inorganic Chemistry (3-0-3).

Chemistry 610a. High Temperature and High Pressure Chemistry (3-0-3).

A study of the techniques for generation and measurement of high temperatures and high pressures and of the nature of phenomena under extreme conditions 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, to plasma phenomena and to the uses of extreme conditions in chemical syntheses.

Chemistry 640a. Chemistry of the Terpenes (3-0-3).

Not offered in 1971-72.

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.

Chemistry 700. Summer Graduate Research

Chemistry 800. Non-Resident Research.

Civil Engineering

(*See* pages 180-186)

Classics, Italian, Portuguese, Russian, and Spanish

Professor Castaneda, *Chairman;* Professors Jitkoff, Levin, and Lopez Morales
Associate Professor Leal de Martinez
Visiting Associate Professor Soons
Assistant Professors Aguirre, Anderson, Gila, Gilmartin, Green, R. G. Jones and Urrutibéheity
Lecturers Eaker and Valdivieso

Work is offered in Greek, Latin, Italian, Portuguese, Russian, and Spanish. Undergraduate majors are presently offered in Classical Studies, Russian, and Spanish. The degree of Master of Arts is offered in Spanish.

A fully equipped language laboratory is 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
Assistant Professor Gilmartin
Lecturer Eaker

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 ten courses, of which twenty-four hours, equal to eight 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 drawn 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. *Miss Gilmartin*

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 and Mrs. Eaker*

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. Offered in 1971-72. *Mr. Levin*

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. Offered in 1971-72. *Miss Gilmartin*

Greek 375a. Greek Prose Composition (3-0-3).

Practice in writing progressively more complex Greek prose in accordance with the best Classical models. Open to Sophomores with permission of the instructor. Not offered in 1971-72.

Greek 490a, b. Special topics in Greek 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. Prerequisite: Greek 300a and b or equivalent. *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 the second semester. *Mrs. Eaker*

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. *Mrs. Eaker and Miss Gilmartin*

Latin 300a. Plautus and Terence (3-0-3).

Study of selected comedies. Consideration will be given to the position of both authors in ancient comic tradition. Prerequisite: Latin 200a,b or three or four years of high school Latin. *Miss Gilmartin*

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. Prerequisite: same as for Latin 300a. *Mr. Levin*

Latin 376b. Latin Prose Composition (3-0-3).

Practice in writing progressively more complex Latin prose in accordance with best Classical models. Open to Sophomores with permission of the instructor. Not offered in 1971-72.

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 1971-72. Prerequisite: Latin 300a and b or equivalent. *Miss Gilmartin*

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 1971-72. Prerequisite: Latin 300 a and b or equivalent. *Mr. Levin*

Latin 420a. Elegiac Poetry (3-0-3).

Readings and discussion of a representative selection of poems by Catullus, Tibullus, Properties, and Ovid. Offered in alternate years. Will be given in 1972-73. 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 1972-73. Prerequisite: Latin 300a and b or equivalent. *Mrs. Eaker*

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. Prerequisite: Latin 360a,b or equivalent. *Staff*

Classics 315a. Greek and Roman Literature in Translation (3-0-3).

A study of Greek and Roman achievement in epic, didactic, and pastoral poetry. No prerequisites. Open to Sophomores. Offered in alternate years. Given in 1972-73. *Miss Gilmartin*

Classics 316b. Greek and Roman Literature in Translation (3-0-3).

A continuation of the foregoing: readings in Greek and Roman drama, history, and philosophy. No prerequisites. Open to Sophomores. Offered in alternate years. Will be given in 1972-73. *Miss Gilmartin*

Classics 321a, 322b. 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 1972-73. Prerequisite: History 201a, 202b. Also offered as History 321a, 322b. *Mr. Lear*

Classics 335a. Classical Mythology (3-0-3).

Survey of Greek myths with their extension to Rome, followed by study of a few individual cycles as treated not only by Greek and Roman authors, but by modern authors as well. All texts will be assigned in English, though students capable of handling Greek, Latin, French, or German originals will be encouraged to do so. No prerequisites. Open to Sophomores. Offered in alternate years. Will be given in 1971-72. *Mr. Levin*

Classics 336b. Classical Mythology (3-0-3).

Continuation of the foregoing, which, while not strictly a prerequisite, were better taken first. Several additional cycles of myth or legend will be explored both in ancient and in modern treatment. Open to Sophomores. Offered in alternate years. Will be given in 1971-72. *Mr. Levin*

Classics 431a. 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 1971-72. Prerequisite: History 200a, 201b. Also offered as History 431a, 432b. *Mr. Lear*

ITALIAN

ASSISTANT PROFESSOR AGUIRRE

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.

PORTUGUESE

ASSISTANT PROFESSOR GREEN

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. Green*

RUSSIAN

PROFESSOR JITKOFF
ASSISTANT PROFESSORS ANDERSON, JONES AND THOMPSON

Undergraduate Major. At least eight of the courses offered in fulfillment of major requirements must be numbered 300 or higher. All departmental majors must have their programs approved by a representative of the department. Students with a double major should consult with the Russian staff to arrange a program compatible with the other major.

Russian 100a, b. Elementary Russian (3-2-4, each sem.).

Fundamentals of Russian grammar. Pronunciation, reading, oral practice, and translation. *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. Not offered in 1971-72. *Mr. Jitkoff*

Russian 200a. Intermediate Russian (3-0-3).

Grammar review, reading of selected texts, conversation and composition. *Messrs. Jitkoff and Jones*

Russian 200b. Intermediate Russian (3-0-3).

Grammar review, reading of selected texts, conversation and composition. *Mr. Jones*

Russian 201b. Intermediate Russian: Scientific (3-0-3).

Reading and translation of texts in the student's special field of interest. *Mr. Jitkoff*

Russian 300a. Russian Culture and Civilization (3-0-3).

Reading of texts depicting Russian culture and its development. Advanced grammar, oral, and written reports. *Mr. Jitkoff*

Russian 300 b. Reading in Russian Classics (3-0-3).

A study of the shorter works of Russian literature. Oral and written reports. *Mr. Jitkoff*

Russian 330a, b. History of Russian Literature (3-0-3, each sem.).

A comprehensive survey of Russian literature from its beginnings in the Kievan period to the present. Readings and lectures are in English, but students with the equivalent of two years of Russian are expected to do part of the readings in Russian and to participate in special Russian discussions. *Mr. Anderson*

Russian 340a, b. Studies in Nineteenth Century Literature (3-0-3, each sem.).

Comprehensive study of the major writers and literary trends of the nineteenth century. May be repeated when the topic varies. Topics will include: Pushkin; Dostoevsky; Tolstoy; Turgenev, Chekhov, Russian Realism; Russian Romanticism. Readings and lectures are in English, but students with the equivalent of two years of Russian are expected to do part of the readings in Russian and to participate in special Russian discussions. 1971-72 topics: 340a, Tolstoy; 340b., Gogol. *Mr. Anderson*

Russian 400a, b. Russian Stylistics (3-0-3, each sem.).

Comparative analysis of literary works. Special emphasis is placed on recognizing stylistic features of a work and developing familiarity with basic concepts of literary investigation. Not offered 1971-72.

Russian 410. Soviet Russian Literature (3-0-3).

A survey of Russian literature of the Soviet period from its formation early in the twentieth century to the "thaw" of the late fifties and sixties. Not offered 1971-72.

Russian 420. Survey of Russian Poetry (3-0-3).

A study of Russian poetry from Pushkin and Lermontov to the present. Not offered 1971-72.

Russian 430. Russian Literature before the Nineteenth Century (3-0-3).

A survey of Russian literature from its origins in the tenth century up to and including the neoclassical period of the eighteenth century. Not offered 1971-72.

Russian 440. Special Topics in Russian Literature (3-0-3).

Topics will change and the course may be repeated for credit. Topics will include Russian drama, Symbolism, history of Russian literary criticism, and oral literature. Not offered 1971-72.

Russian 450a, b. Independent Study (3-0-3, each sem.).

Qualified students may conduct research and write a paper on a topic of particular interest. *Staff*

SPANISH

PROFESSORS CASTAÑEDA AND LOPEZ MORALES
ASSOCIATE PROFESSOR LEAL DE MARTÍNEZ
VISITING ASSOCIATE PROFESSORS SOONS
ASSISTANT PROFESSORS AGUIRRE, GILA, GREEN AND URRUTIBÉHEITY
LECTURER VALDIVIESO

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.

Requirements for the Degree of Master of Arts in Spanish.

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 Spanish approved by the department.
c) Passing an oral examination in Spanish based in part on a reading list provided by the department.
d) Completion of an acceptable thesis.
e) Passing a final oral examination on the thesis.

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 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 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. Given Spring semester, 1972.
Mr. Aquirre

Spanish 303a, 304b. Spanish American Literature in Translation (3-0-3).

Given Fall semester, 1971. *Messrs. Aquirre and Castaneda*

Spanish 310a, b. Advanced Spanish (3-0-3, each sem.).

A third year course designed primarily to improve the student's command of the spoken language. Emphasis will be placed on the acquisition of new vocabulary and idioms. Spanish morphology and syntax and the various mechanisms of interference will be studied in detail. *Staff*

Spanish 315a. Spanish Phonetics (3-0-3).

A description of Spanish phonetics including major dialectical variants. Specific emphasis will be placed on an analysis of the most frequent types of English interference. Active practice in pronunciation and intonation. Given Fall Semester, 1972.
Mrs. Green

Spanish 316b. Advanced Spanish Syntax and Composition (3-0-3).

A detailed study of Spanish syntax with special attention to the interference caused by structural differences between English and Spanish. Given Spring Semester, 1973. *Mr. Urrutibéheity*

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: Given in 1972-73. *Mrs. Green*

Spanish 324b. The Culture and Civilization of Latin America (3-0-3).

Topics relating to the development of social, political, and economic institutions of Latin America 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 Latin America. Given Spring Semester, 1973. *Staff*

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: Given in 1971-72. *Mr. Gila*

Spanish 350a. History of the Spanish Language (3-0-3).

The development of Spanish from the Romanization of Spain to our times: Linguistic, cultural, social and regional factors which have led to modern Spanish. Given Fall Semester, 1971. *Mr. Urrutibéheity*

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 Alarcon, Calderón de la Barca, and other seventeenth-century playwrights. Offered in alternate years: Given in 1972-73. *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: Given in 1971-72. *Mr. Soons*

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: Given in 1972-73. *Mr. Aguirre*

Spanish 410a, b. Medieval and Renaissance Spanish Literature (3-0-3, each sem.).

The topic will change from year to year. Among works to be studied in 1970-71 will be *El Corbacho, La Celestina,* theatre before Lope de Vega, lyric poetry to Garcilaso. Not offered, 1971-72. *Mrs. Leal de Martínez*

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*

Spanish 500a. Seminar in Hispanic Literature (3-0-3, each sem.).

The topic will change from year to year. Fall, 1971: Picaresque Novel. *Mr. Castañeda*

Spanish 511a. Methods of Research in Hispanic Literature (3-0-3).

Will be given Fall Semester, 1972. *Mr. López Morales*

Spanish 512b. Methods of Research in Hispanic Linguistics (3-0-3).

Spanish 511a and 512b comprise a theoretical and practical course for the beginning graduate student. Emphasis will be placed on the techniques of stylistic and linguistic analysis, and on acquainting the student with the bibliographic resources of the field. Given Spring Semester, 1972. *Mr. López Morales*

Spanish 515a. Applied Spanish Linguistics (3-0-3).

A study of the teaching of Spanish Grammar and Phonology from the point of view of general linguistic theory. Given Fall Semester, 1972. *Mr. Urrutibéheity*

Spanish 517a, b. Studies in Medieval Spanish Literature (3-0-3, each sem.).

Fall, 1971: Medieval Epic; Spring, 1972: Theatre before Lope. *Mr. Soons*

Spanish 523a. Studies in Golden Age Theatre (3-0-3).

(The cycle of Lope de Vega). Given in Fall Semester, 1972. *Mr. Castañeda*

Spanish 524b. Studies in Golden Age Theatre (3-0-3).

(The cycle of Calderón). Given Spring Semester, 1973. *Mr. Castañeda*

Spanish 541a, 542b. Studies in Spanish Literature of the Twentieth Century. (3-0-3, each sem.).

Topic for 1971-72: Novel *Mr. Aguirre*

Spanish 555a, 556b. Studies in Spanish American Literature from the Colonial Period to the Present Day (3-0-3, each sem.).

The topic will change from year to year. Fall, 1971: Modern Novel; Spring, 1972: Contemporary Novel. *Mrs. Green*

Spanish 562b. Spanish American Dialectology (3-0-3).

Given Spring, 1972. *Urrutibéheity*

Spanish 575b. Introduction to Romance Linguistics (3-0-3, each sem.).

The development of the Romance languages from Vulgar Latin and the creation of Romance standards. Given in Spring Semester, 1971. *Mr. Urrutibéheity*

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.

Economics 445a. Linear Programming (3-0-3).

Short- and long-term financing of assets; investment banking: tools of financial analysis; budgets and financial planning.

Economics 420a. International Economics (3-0-3).

Personnel management and employee relations; personnel policies; job evaluation; wage and salary administrators; 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 Accounting

PROFESSOR HUDDLE, *Chairman;* PROFESSORS KRZYZANIAK, LEVY, RIMLINGER, WIEST, AND YOUNG
ASSOCIATE PROFESSOR BESEN, BURNS, LAND, MCLURE, AND SOLIGO
VISITING ASSOCIATE PROFESSOR BOWERS
ASSISTANT PROFESSORS JOHNSON, SEAGRAVE, AND SMITH
VISITING ASSISTANT PROFESSORS STRUYK
INSTRUCTORS ERIS AND LARGAY
LECTURERS GILES AND VIEBIG

I. Economics:

The Undergraduate Program in Economics. Undergraduate majors are required to take:

1. A minimum of 9 courses in Economics.
2. Economics 201 and 370
3. Either Economics 375 or 355
4. At least 4 of the following: Economics 202, 355*, 415, 416, 420, 422, 430, 435, 446, 447, 450, 455, 460, 475.

* Students may take Economics 355 to satisfy this requirement only if they have taken Economics 375 to satisfy the requirement in macro theory.

Mathematics 101a, 102b or 103a, 104b and Mathematical Sciences 381a and 480b are 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. (see page 168)

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 Economics 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 fulltime 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.

(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. Demonstrate proficiency in statistics, elementary mathematical economics, and economic history or history of economic thought.
2. Complete an approved program of graduate courses.

3. Pass written general examinations on:
   a. Economic Theory
   b. Major field examinations covering two of the following areas:
      (1) International Economics (Trade and Finance)
      (2) Public Finance and Fiscal Policy
      (3) Monetary Economics (Theory and Policy)
      (4) Economic Development and History
      (5) Econometrics and Statistics
      (6) Mathematical Economics
      (7) Managerial Economics and (a) Labor, (b) Operations Research, or (c) Industrial Organization
      (8) Industrial Organization and Labor
4. Upon satisfactory completion of the written examinations, pass an oral examination emphasizing economic theory and the major areas.
5. Submit (with the approval of the advisory committee) and successfully defend in an oral examination 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) Successful completion of six courses, no more than three at the undergraduate level.
(2) Attainment of a grade point average exceeding 2.5 in all courses, except the thesis.
(3) Successful completion of a Master's thesis.

A Master's degree may also be awarded to students who attain candidacy for the Ph.D. degree.

ECONOMICS COURSES

Economics 201a or b. Principles of Economics. (3-0-3).

The course is concerned with the theory of national income determination, price and distribution theory, and the theory of trade.

Economics 202b. Principles of Economics. (3-0-3).

The course is a study of the great economic ideas and issues of the past and present, with emphasis on those ideas and policy issues of continuing influence in national and international economic affairs.

Economics 204b. Principles of Urban Economics. (2-3-3).

A course offered for Urban Design students. Analysis of the problems of the city with special attention to problems and metropolitan finance and local governmental organizations, poverty, housing, and transportation.

Economics 350a. Elements of Statistical Method (3-2-3).

Basic concepts and techniques in probability theory and statistical inference.

Economics 355b. 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 201a or 201b.

Economics 370a, b. 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 201a or 201b.

Economics 375a, b. 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 201a or 201b.

Economics 400b. Econometrics. (3-0-3).

Evaluation of models of economic behavior by statistical methods. Prerequisite: Economics 350a or permission of the instructor.

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 finding of the research. Enrollment is 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 201a or b or approval of the instructor.

Economics 415a. Economics and Wages and Human Resources (3-0-3).

Study of labor markets and wage determination. Special emphasis on "investment in human capital" through education, traning, and health services. Attention devoted also to the determinants of labor mobility and work force participation, and to the economic implication of discrimination. Prerequisite: Economics 201a or b.

Economics 420a. International Economics (3-0-3).

The basic theory will be developed through analysis of current international economic problems: dollar crisis; economics and politics of international petroleum; multinational corporation; challenge of European Common Market; determinants of tariff protection; trade and the poor countries. Prerequisite: Economics 201a or b.

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 201a or b.

Economics 422b. International Economic Relations (3-0-3).

Analyses of the economic problems of the Atlantic Community, the United

States, and the Third World. Topics will include problems of the International Monetary System, National versus International Interests, and Conflict Resolution. Prerequisite: Economics 201a or b, Economics 420a or approval of the instructor.

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 201a or b.

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 201a or b or approval of instructor.

Economics 455a. 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 201a or b.

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 201a or b.

Economics 447a. Corporation Finance (3-0-3).

Financial analysis, planning, and control in modern corporations. Topics covered include valuation, types and sources of financing, cost of capital theory, internal allocation of capital, and capital markets. Prerequisie: Economics 201a or b. Also offered as Accounting 447a.

Economics 450b. The Economic Development of the Poor Countries (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 201a or b.

Economics 455a. Latin American Economic Development (3-0-3).

Survey of recent economic history of major Latin American countries dealing with the institutional background and the structure of present economic activities. Special attention devoted to current problems of economic growth and social transformation. Prerequisite: Economics 201a or b.

Economics 460a. Urban Economics (3-0-3).

An economic analysis of cities, with special emphasis on problems in the areas of housing, transportation, government taxation, race relations, pollution, and recreation facilities. Prerequisite: Economics 201a or b.

Economics 475b. Public Finance (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 201a or b.

Economics 481a. Operations Research, Deterministic Models (3-0-3).

An introduction to deterministic models of operations research, beginning with a review of classical optimization techniques and including linear programming, network models, dynamic programming, branch and bound techniques, heuristic approaches, and game theory. Present value concepts and capital investment decisions will also be discussed. Prerequisite: Economics 201a or b or approval of instructor. Also offered as Engineering 481a and Accounting 571a.

Economics 482b. Operations Research, Stochastic Models (3-0-3).

A study of elementary stochastic processes and related decision models of operations research. Includes an introduction to statistical decision theory, queueing theory, inventory models, Markov chains, replacement models, quality control, and computer simulation techniques. Prerequisite: Economics 481a or approval of instructor. Also offered as Engineering 482b, Accounting 572b and Masc. 476b.

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, b. 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 501a. 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 502a. Income and Employment Theory (3-6-5).

Macroeconomic theory of employment, interest, and income. Considers the work of Keynes and subsequent developments.

Economics 503b. Topics in Economic Theory (3-6-5).

Selected theoretical issues in the areas of model building, aggregation, index numbers, and macro-welfare; capital and distribution theories.

Economics 504b. Mathematical Topics in Economic Theory (3-6-5).

Selected theoretical issues in the areas of capital, welfare economics, uncertainty, growth, and income treated mathematically. Substitutes for Economics 503 for the more quantitatively oriented student.

Economics 505b. Monetary Theory (3-6-5).

Modern monetary theory. The economics of money, banking, and finance.

Economics 506b. Monetary and Fiscal Policy (3-6-5).

Commercial bank behavior and the supply of money; instruments of monetary control; the role of nonbank financial intermediaries; instruments of fiscal control; monetary rules and automatic stabilizers; monetary targets and indicators; inflation.

Economics 507a. 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 508a. Advanced Mathematical Economics (3-6-5).

The mathematical framework and the analytical investigation of fundamental models in economics.

Economics 509a. 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 510b. 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.

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.

Economics 519. Economic Growth and Development (3-6-5).

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 520. Workshop in Economics I. (3-0-3).

Intensive study of selected advanced topics.

Economics 521. Workshop in Economics II. (3-0-3).

Intensive study of selected advanced topics.

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.

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.

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.

II. Accounting:

The Five Year Program in Accounting. The only degree offered in accounting is the professional degree of Bachelor of Science in Accounting which requires a total of five years to complete (four years at the undergraduate level and one at the graduate level). A proposal is now pending to change the degree from a second bachelor's to a Master of Accounting. Students are allowed to choose any undergraduate major they wish (most tend to major in economics, mathematical sciences, or commerce) provided that they fulfill all the prerequisites for admission to the fifth-year accounting program. The prerequisites are as follows: Economics 201 and 350 (Masc. 380 and 480 may be substituted for Economics 350); Engineering 240; Accounting 200, 301, 302, 451, and 452 (Economics 446 may be substituted for Accounting 452). Psychology 303 is also recommended but not required. Other economics courses which are relevant to the accounting program are Economics 355, 370, 416, 435, 447, 475. Early in the Spring Semester of the senior year, students apply for admission to the fifth-year program in accounting. Departmental approval is typically granted to all students with the appropriate prerequisites and satisfactory academic records.

Upon admission to the fifth-year program, students are given two choices of specialization: (1) the financial accounting option which prepares students for careers in public accounting, and (2) the managerial accounting option which prepares students for careers in industry. Those electing the financial accounting option are required to enroll in Accounting 501, 511, 515, 551, 581, and 598. In addition, Political Science 310a is also required if not previously taken. Students electing the managerial accounting option are required to enroll in Accounting 511, 551, 571, 572, 582, and 598.

A total of ten courses is required for the fifth-year degree; thus up to four electives are permitted during the fifth year. These electives must be chosen from among upper-division courses in consultation with the student's advisor.

ACCOUNTING COURSES

Accounting 200a or b. Introduction to Accounting (3-0-3).

The study of basic accounting theory and practice. A thorough coverage of the accounting measurement of income and financial position. Emphasis is placed on the analysis of business events and their effect on the financial position and income of the business. Special attention is paid to asset valuation and its effect on income determination. Critical evaluation and interpretation of published financial reports is a significant part of the course.

Accounting 301a. Financial Accounting I (3-0-3).

The topics covered in this course include the recording process, the reporting process, and the valuation of assets and the attendant effect on income determination. Reference will be made to selected professional literature. Prerequisite: Accounting 200.

Accounting 302b. Financial Accounting II (3-0-3).

The topics covered in this course include liabilities, corporate capital accounts, special problems of income determination, fund statements, and statement analysis. Reference will be made to selected professional literature. Prerequisite: Accounting 301.

Accounting 451a. Managerial Accounting I (3-0-3).

Accounting data for managerial control and decision-making are stressed. Topics covered include budgets, standard costs, profit planning, cost behavior, and accounting information for mathematical decision models. Prerequisite: Accounting 200.

Accounting 452b. Managerial Accounting II (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 201. Also offered as Economics 446.

Accounting 501a. Advanced Financial Accounting (3-0-3).

The topics covered in this course include partnerships, branch accounting, consolidated statements, governmental accounting, and special problems. Reference will be made to selected professional literature. Prerequisite: Accounting 302.

Accounting 511a. Federal Income Taxation (3-0-3).

A comprehensive examination of the fundamental characteristics of the federal income tax as applied to corporations and individuals. Emphasis is placed upon the recognition of an income tax problem and the timely arrangement of corporate and individual transactions to produce the most favorable income tax consequences. Prerequisite: Accounting 200.

Accounting 515a. Auditing (3-0-3).

Primarily concerned with those auditing standards and procedures associated with the public accounting profession. The topics covered include audit reports, professional ethics, legal responsibilities, audit programs, and audit working papers. Prerequisites: Accounting 302 and Accounting 501 (Accounting 501 may be taken concurrently).

Accounting 551a. Accounting and the Computer (3-0-3). (Not offered in 1971-72).

This course provides practical experience in using computers for accounting purposes and for planning. Emphasis is on the need to design programs so that accounting and planning are achieved without damaging side effects. Implementation of internal control procedures is discussed in the accounting applications. The characteristics of file storage, storage media, and data bank design are considered. Use of the computer to assist managers in the planning process, through time-sharing and simulation is also considered. Students participate in the preparation of systems analysis and programs with specific accounting and business uses. Prerequisites: Accounting 451 and Engineering 240.

Accounting 571a. Operations Research, Deterministic Models (3-0-3).

An introduction to deterministic models of operations research, beginning with a review of classical optimization techniques and including linear programming, network models, dynamic programming, branch and bound techniques, heuristic approaches, and game theory. Present value concepts and capital investment decisions will also be discussed. Prerequisite: Economics 201 or approval of instructor. Also offered as Engineering 481a and Economics 481a.

Accounting 572b. Operations Research, Stochastic Models (3-0-3).

A study of elementary stochastic processes and related decision models of operations research. Includes an introduction to statistical decision theory, queueing theory, inventory models, Markov chains, replacement models, quality control, and computer simulation techniques. Prerequisite: Economics 201 or approval of instructor. Also offered as Engineering 482b and Economics 482b.

Accounting 581b. Seminar in Financial Accounting Issues (3-0-3).

Primary emphasis will be given to contemporary developments in all areas of accounting principles and practice. Source material will include current accounting literature and publications of such organizations as the American Accounting Association and the American Institute of Certified Public Accountants. Prerequisite: Accounting 501.

Accounting 582b. Seminar in Managerial Accounting Issues (3-0-3).

The seminar examines the literature on profit planning and control with special emphasis on the relationship of the organizational structure, the behavior of individuals, and limitations of accounting methodology and data to planning and control. The relationship of traditional accounting models to measures used in decision-making is considered. Prerequisite: Accounting 451 and 452.

Accounting 598b. Seminar in Income Determination Theory (3-0-3).

Theoretical and practical problems in the measurement of business income determination. Conventional procedures and generally accepted accounting principles are appraised in light of income determination theory. Prerequisite: Accounting 501.

Education

PROFESSOR WOOD, *Chairman*
LECTURER BAUM
R. D. DUKE, *Director of Student Teaching*

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, earth science, economics, English, French, German, health and physical education, history, Latin, mathematics, physics, political science, Russian, general science, and Spanish.

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) 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 professtional 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). English Teachers Only

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 411b. Seminar in Teaching (3-0-3). Social Studies Teachers Only

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 412b. Seminar in Teaching (3-0-3). Math and Science Teachers Only

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 413b. Seminar in Teaching (3-0-3). Health and Physical Education Teachers Only

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 414b. Seminar in Teaching (3-0-3). Foreign Language Teachers Only

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 condidates. 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 a neighboring school system and may select one of two plans.

(1) Two Interns will be employed as a pair for fulltime duty to take the place of a normally employed teacher. Each Intern is to teach three periods per day under the 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. Upon the successful conclusion of the Internship semester and upon the recommendation of the appropriate secondary-school principal, the Intern will be given preference for a regular teaching position in the spring semester should there be a suitable vacancy and will be recommended for a Texas Provisional Teacher's Certificate. However, there is no guarantee that the Intern will be offered a regular teaching position the semester following Internship.

(2) The Intern will be employed for fulltime duty and will teach five periods per day under the supervision and guidance of a staff member of the cooperating school system and a staff member from the University. During the half-year of his service the Intern will be paid a salary commensurate with the salary being paid a fulltime teacher with a degree and an emergency teaching permit by cooperating school systems for their employment as classroom teachers. Upon successful completion of the Internship semester and upon the recommendation of the appropriate secondary-school principal, the Intern will be offered a regular teaching contract for the spring semester if a suitable vacancy exists and will be recommended for a Texas Provisional Teacher's Certificate.

Electrical Engineering

(*See* pages 187-194)

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, environmental science and engineering and mechanical engineering.

The first two years of the science-engineering program taken by all are described generally on pages 61-62. Students contemplating a major in engineering should pay particular attention to the courses required by the various engineering departments as shown in the appropriate section of this catalog.

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 211. Engineering Mechanics I (3-0-3).

Equilibrium of static systems, dynamics of a particle, dynamics of particle systems, and rigid-body dynamics. Elements of vibrational analysis. Prerequisites: Physics 100a,b, Mathematics 101a, 102b.

Engineering 240. Introduction to Computer Science (3-3-4).

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. Circuit and Systems Analysis (3-4-4).

Formulation and solution of network equations with applications to systems. Prerequisite: Mathematics 101a, 102b.

Engineering 481a. Operations Research, Deterministic Models. (3-0-3).

An introduction to deterministic models of operations research, beginning with a review of classical optimization techniques and including linear programming, network models, dynamic programming, branch and bound techniques, heuristic approaches, and game theory. Present value concepts and capital investment decisions will also be discussed. Prerequisite: Economics 201a or b or approval of instructor. Also offered as Economics 481a and Accounting 571a.

Engineering 482b. Operations Research, Stochastic Models (3-0-3).

A study of elementary stochastic processes and related decision models of operations research. Includes an introduction to statistical decision theory, queueing theory, inventory models, Markov chains, replacement models, quality control, and computer simulation techniques. Prerequisite: Economics 201a or b or approval of instructor. Also offered as Economics 482b and Accounting 572b.

Chemical Engineering

PROFESSOR HELLUMS, *Chairman;* PROFESSORS AKERS, S. DAVIS, DEANS, HIGHTOWER, JACKSON, KOBAYASHI AND LELAND
ASSOCIATE PROFESSOR DYSON
ASSISTANT PROFESSORS ARMENIADES AND MCINTIRE

Undergraduate Program. A general outline of the undergraduate engineering program is given on pages 65-66. A list of courses specifically required by the department is available from the Chemical Engineering Advisor in each college or from the Departmental office, 246 Abercrombie Lab.

The undergraduate curriculum in Chemical Engineering is designed to provide a sound scientific and technical basis for further professional development. Concurrently, the student has the opportunity of concentration in a particular technical specialty of his choice. After close consultation with his academic advisor, the student may elect a group of courses in an area such as applied mathematics, biomedical engineering, nuclear technology, environmental quality, kinetics and catalysis, engineering economics, or polymer science and engineering. A more general selection of electives may be indicated in certain cases.

Successful completion of the four year curriculum qualifies the student for the Bachelor of Arts degree, with a major in Chemical Engineering. He is then eligible to apply for a fifth year of specialized study leading to the degree of Master of Engineering in Chemical Engineering, which is the recognized professional degree. The curriculum is designed so that outstanding students interested in careers in research and teaching may enter graduate school after the B.A. degree.

Graduate Program. Graduate study in Chemical Engineering can lead either to the Master of Science or the Doctor of Philosophy degree. University requirements for these degrees are outlined on pages 109-110.

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 one foreign language, and in the areas of applied mathematics, thermodynamics, transport processes, and chemical kinetics and reactor design, by passing qualifying examinations, normally during his first year of study. He must also complete a minimum of twelve approved one-semester courses, with high standing and submit a thesis which provides evidence of his ability to carry out original research in a specialized area of Chemical Engineering. The thesis must be defended in a public oral examination.

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 both steady and unsteady state systems.

Chemical Engineering 302b. Separation Processes I (3-0-3).

A systematic treatment of single and multistage contacting operations involving binary and multicomponent systems. The systems are studied using finite difference calculus when appropriate. The operations discussed include distillation, absorption, leaching, and extraction.

Chemical Engineering 343b. Chemical Engineering Laboratory (0-3-1).

Experiments demonstrating the principles presented in Chemical Engineering 301a and 302b.

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. Introduction to Transport Phenomena (3-0-3).

A continuation of Chemical Engineering 401a.

Chemical Engineering 411a. Fundamentals of Thermodynamics (3-0-3).

Development and application of the first and second laws of thermodynamics.

Chemical Engineering 412b. Fundamentals of Thermodynamics (3-0-3).

Continuation of Chemical Engineering 411a. Topics include chemical equilibria, non-ideal solutions, equations of state, and the corresponding states principle.

Chemical Engineering 443a, b. Chemical Engineering Laboratory (0-3-1, each sem.).

Experiments demonstrating transport coefficient measurement, forced and free convection transfer operations, and thermodynamic principles as covered in Chemical Engineering 401a, 402b, 411a.

Chemical Engineering 490b. 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 501a. Fluid Mechanics and Transport Processes (3-0-3).

Advanced study in fluid mechanics and transport processes including analytical and numerical approximation methods, boundary layer theory and hydrodynamic stability.

Chemical Engineering 503a, b. Simulation and Design of Chemical Engineering Processes (4-6-6, each sem.).

A synthesis course applying the principles of staged processes, transport phenomena, kinetics, and economics to the simulation, design and operation of equipment and processes.

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 529a. Topics in Air Pollution (3-0-3).

Lectures and discussions of life cycles of major pollutants and technology of abatement. Also considered are economic and sociological aspects as well as legal problems of standards and enforcement.

Chemical Engineering 529b. Topics in Air Pollution (3-0-3).

Outstanding authorities in the area of air pollution abatement will be combined with class discussions to cover the integration of pollution control in chemical engineering processing. Emphasis will be placed on case studies in the relatively new area of technology assessment. Also considered are the evolution of reasonable enforceable standards.

Chemical Engineering 551a or b. Advanced Separation Process II (3-0-3).

A quantitative study of multistage calculations for multicomponent systems; digital computer solutions of separation problems; the development of mathematical models for real stages.

Chemical Engineering 590a. Kinetics, Catalysis and Reactor Design (3-0-3).

Chemical reaction rates, reaction mechanisms, theories of catalysis, diffusion in porous solids, reactor design and optimization.

Chemical Engineering 594a, b. Polymer Science and Engineering (3-0-3, each sem.).

Basic concepts in macromolecular chemistry and physics, and their application in the production, processing and use of synthetic polymers. (a) Polymer synthesis,

Chemical Engineering 601a or b. Advanced Topics in Fluid Mechanics and Transport (3-0-3).

Advanced study in several areas of fluid mechanics or transport including tensor analysis, continuum mechanics, rheology, and mathematical methods of special interest in fluid mechanics.

Chemical Engineering 602b. Physico-Chemical Hydrodynamics (3-0-30).

Topics in hydrodynamics including waves on liquid surfaces, diffusion in liquids, motion of drops and bubbles and electrophoresis.

Chemical Engineering 611a or b. Advanced Topics in Thermodynamics (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 631a. Nuclear Engineering (3-0-3).

The application of nuclear properties, nuclear reactions, and neutron diffusion theory to the design of nuclear reactors. Basic principles of the kinetics and control of nuclear reactor systems are presented.

Chemical Engineering 632b. Nuclear Engineering (3-0-3).

A continuation of Chemical Engineering 631a with a more advanced treatment of nuclear reactor theory using 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 660a 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 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 675a 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 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 691a or b. Advanced Topics in 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.

Chemical Engineering 800a,b. Degree Candidate Only.

Civil Engineering

Professor Veletsos, *Chairman;* Professors W. J. Austin, Krahl and Sims
Associate Professors Holt, Jirsa and Merwin
Assistant Professors 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, stadiums, dams, and marine and space platforms;
b) transportation systems and facilities 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.

The knowledge required for the design of the civil engineering structures referred to above is substantially the same as that required for the design of aircraft structures, rockets, ships, and underwater and space vehicles. Students interested in the structural aspects of aerospace engineering will find that the civil engineering curriculum provides an excellent preparation for a productive career in this field. The same is also true of students interested in the phase of ocean engineering dealing with the design of the special structures required for the exploration and exploitation of the oceans.

Undergraduate Program. The general requirements for Civil Engineering degrees are described on pages 65-66. The curriculum is designed to provide a sound basis for future professional growth. A typical program includes fundamental courses in mathematics and the engineering sciences, and specialized course in structural engineering and mechanics, soils and foundation engineering, transportation engineering, fluid mechanics, hydraulics, and hydrology and in environmental engineering. The program also provides for a number of electives which permit a considerable amount of specialization to be obtained in structural engineering and mechanics and in 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 adviser.

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. 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. 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 109-110.

A candidate for the Master of Civil Engineering degree is required to complete ten semester-courses. At least five of these courses must be graduate level civil engineering courses and two may 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 on structural and foundation dynamics, plate and shell structures, numerical analysis and computer utilization, optimal structural design, plasticity, and concrete and steel technology.

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 the Rice computer, a Burroughs 5500 and an IBM 7094.

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 301. Strength of Materials Laboratory (0-3-1).

Standard tension, compression, and torsion tests of ferrous and non-ferrous metals; experimental techniques; behavior of structural elements. Laboratory fee required. *Mr. Merwin*

Civil Engineering 304. Structures I (3-0-3).

The first course in a three course sequence in structural analysis, behavior and design. Analysis and design of beams, tension and compression members, and trusses. Discussion of material behavior as related to design in steel, timber and concrete. Beam and truss deflections. Approximate analysis of indeterminate structures. Prerequisite: Civil Engineering 300. *Mr. Holt*

Civil Engineering 305. Structures II (3-0-3).

Force and displacement methods of structural analysis. Computer analysis of structures. Behavior of metals and metal members. Analysis and design of plate girders, roof trusses, simple bridge trusses and building frames. Introduction to plastic design of steel members and to design of composite members and light gage structures. Prerequisite: Civil Engineering 304. *Mr. Vann*

Civil Engineering 350. Surveying Laboratory (0-3-1).

Fundamental surveying principles and techniques, with emphasis on surveys for major transportation routes. Laboratory fee required. *Mr. Vann*

Civil Engineering 404. Structures III (3-3-4).

Behavior and design of reinforced concrete members and frameworks. Introduction to prestressed concrete. Design of typical parts of buildings, bridges and foundations. Laboratory tests of structural materials and structural members under flexure and axial load. Laboratory fee required. Prerequisite: Civil Engineering 305. *Mr. Jirsa*

Civil Engineering 405. Structures IV (3-0-3).

Design of complete structural systems for buildings and bridges. The potentialties and limitations of contemporary structures. Calculation of loads. Choice of structural materials and structural systems. Cost estimates. Optimum structures. Examples and case studies to include high rise, space frame, shell, cable-supported and air-supported structures. *Mr. Krahl*

Civil Engineering 434. Design of Steel 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, energy concepts in steady flow, momentum and dynamic forces, similitude and dimensional analysis, steady flow in conduits and pipe networks, ideal fluid flow, drag forces. Engineering applications. *Mr. Austin*

Civil Engineering 461. Hydraulics and Hydrology (3-0-3).

Applications of principles of fliud mechanics to open channel flow: uniform and gradually varied flow, water surface profiles, hydraulic jump, weirs, gates, etc. Elements of engineering hydrology including study of the hydrologic cycle, rainfall and runoff, frequency and duration relationships, stream flow records, flood routing. Applications of hydrology to municipal water supply, drainage, and flood control problems. Prerequisite: Civil Engineering 460 or equivalent. *Mr. Austin*

Civil Engineering 470. Soil Mechanics and Foundation Engineering I (3-3-4).

Geological origins and characteristics of soils. Soil classifications. Basic principles of soil behavior with applications to the practical analysis and design of shallow and pile foundations, retaining walls, and earth slopes. Standard laboratory tests and discussion of field exploration procedures. *Mr. Jirsa*

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 495. Design of Civil Engineering Systems (3-0-3).

In this course the material covered in previous civil engineering courses is integrated along with economic and financial considerations into the synthesis of civil engineering systems. *Mr. Sims*

Civil Engineering 499. Special Problems (Variable Credit).

Study of selected topics including individual investigations, special lectures and/or seminars. *Staff*

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 by Matrix Methods (3-0-3).

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 305 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. Review of basic structural theorems. Applications of numerical procedures to the determination of influence lines. Methods for the integration of initial value problems in ordinary differential equations. *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).

Further discussion of several of the topics covered in Civil Engineering 470, with special emphasis on stress distribution in soils and bearing capacity of foundations. Dynamic properties of soils, and analysis and design of dynamically loaded foundations.

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 of formulating exact and approximate governing equations for complex physical situations involving discrete (lumped parameter) and continuous systems. Finite difference, finite element, discrete element, and series methods for the approximate solution of boundary value problems in ordinary and partial differential equations. Numerical procedures for the solution of eigenvalue problems. Applications to problems in stress analysis, buckling, and vibrations. *Mr. Austin*

Civil Engineering 605. Energy Methods in Applied Mechanics (3-0-3).

Fundamental principles and direct methods of variational calculus. Basic concepts of mechanics of deformable solid bodies. Development of variational principles of mechanics, including virtual work, stationary potential energy, complementary energy, Reissner's variational theorem, and Hamilton's Principle. Applications to equilibrium problems, using both small and large deformation theories, and to problems of stability and dynamics. *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; optimum plastic design of structures; 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. Propagation of waves, with special reference to the effects of earthquakes. Characteristics of strong motion earthquake records, and response of structures to earthquakes. Principles of earthquake-resistant construction. Problems of foundation dynamics and of foundation-structure interaction. Introduction to vibration of arches, plates and cylindrical shells. Prerequisite: Civil Engineering 520 or equivalent. *Mr. Veletsos*

Civil Engineering 622. Random Vibration (3-0-3).

Dynamics of vibratory systems subjected to random excitation. Both single-degree-of-freedom and multi-degree-of-freedom systems with stationary and non-stationary 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, 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 Structural 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. Methods of limit design for beams and frames. Design and analysis of floor slabs including yield-line theories. Design considerations for structures subjected to earthquake and blast loadings. 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. 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*

Civil Engineering 800. Research and Thesis for Non-Resident Students.

Graduate students who have not completed all of the requirements for an advanced degree and are neither on campus nor using the facilities of the University in the year in which they expect to receive their degree should register in this course for one semester of that terminal year. *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 Mathematical Sciences and under Mathematics, to the additional courses in mechanics offered in the Department of Mechanical and Aerospace Engineering and Materials Science, to courses listed under Environmental Science and Engineering, and to courses in urban design and building systems design offered in the School of Architecture.

Electrical Engineering

PROFESSOR BOURNE, *Chairman;* PROFESSORS DE FIGUEIREDO, GORDON, MCENANY, MINNICK, PEARSON, PFEIFFER AND RABSON
ASSOCIATE PROFESSORS BURRUS, L. E. DAVIS, LEEDS, TITTEL AND TROELSTRA
ASSISTANT PROFESSORS BRANSTON, CLARK, FEUSTEL, HUBAND, JUMP, KIM AND PARKS
LECTURERS CYPRUS, MACPHAIL AND RUSK

The first two years of the science-engineering program are described on page 65 of the catalog. Students contemplating a major in electrical engineering should take Mathematics 101a, 102b, 201a, 202b (or the corresponding honors courses), Physics 100a, 100b, 130b, and Engineering 240a, 241b. Among appropriate electives are Chemistry 120a, 120b, Physics 210a, 210b, 230a, and Engineering 211a, 200b. Other engineering departments may require one or more of these courses and they should be seriously considered as electives.

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 degree of Doctor of Philosophy after completing the Bachelor of Arts degree.

Requirements of a general nature for advanced degrees are outlined on pages 109-110. 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 fundamentals 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 110. 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, computer science and engineering, 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. Network and Systems Theory (3-4-4).

Network equations and topology. Laplace transforms. Input-output relations using impulse and exponential functions. Transfer functions. Relation of poles and frequency response. Prerequisite: Engineering 241.

Electrical Engineering 303. Electromechanical Systems (3-4-4).

Magnetic circuits and transformers; energy and forces in electric and magnetic field systems; lumped parameter electromechanics; rotating machinery and transducers; dynamics and control of electro-mechanical systems.

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: Mathematics 301.

Electrical Engineering 322. Computers and Programming (3-4-4).

Computer structure, machine language, instruction execution, addressing techniques, and digital representation of data. Computer systems organization, logic design, microprogramming and interpreters. Symbolic coding and assembly systems, macrodefinition and generation, and program segmentation and linkage. Several computer projects to illustrate basic machine structure and programming techniques. A knowledge of ALGOL is assumed. Also offered as MaSc 361. Prerequisite: Engineering 240.

Electrical Engineering 324. Computer Organization (3-4-3).

Basic digital circuits, Boolean algebra and combinational logic, data representation and transfer and digital arithmetic. Digital storage and accessing control functions, input-output facilities and system organization. Description and simulation techniques. Prerequisite: Engineering 240.

Electrical Engineering 342. Electronic Circuits (3-4-4).

Primarily linear transistor circuits. Transistor and FET models, bias circuits, time and frequency characteristics of amplifiers, multi-stage amplifiers, and power amplifiers. Feedback amplifiers and oscillators. Electronic Instrumentation. This course is also useful for non-electrical Engineering majors. Prerequisite: Engineering 241.

Electrical Engineering 343. 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 362. Magnetic, Dielectric, and Optical Devices (3-0-3).

Properties of magnetic, dielectric, and optical materials associated particularly with engineering applications in devices. Magnetic circuits, computer memories, magnetic recording, transducers, lenses, filters, and polarizers. Prerequisite: Engineering 241.

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. Prerequisite: Electrical Engineering 301.

Electrical Engineering 406. Electromagnetic Wave Propagation (3-3-4).

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. Linear Control Systems (3-0-3).

Introduction to the representation, analysis and design of linear feedback control systems. Stabilization and optimal control of multi-input, multi-output systems. Realization of compensators to achieve desired stability (or optimality) properties. 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.

Electrical Engineering 422. Introduction to Discrete Structures (3-0-3).

An introduction to several discrete mathematical systems useful in various areas of computer science. Topics considered will include: a review of set theory, relations and mappings; algegraic systems such as semigroups, groups, rings and fields; graph theory Boolean algebra and propositional logic. Also offered as MaSc 460.

Electrical Engineering 423. Data Structures and Programming Languages (3-4-4).

Basic concepts of data representation. Linear lists, strings, arrays and orthogonal lists. Representation of trees and graphs. Storage systems and structures, and storage allocation and collection. Multilinked structures. Symbol tables and searching techniques. Sorting (ordering) techniques. Formal specification of data structures, data structures in programming languages, and generalized data management systems. Formal definition of programming languages including specification of syntax and semantics. Simple statements including precedence, infix, prefix and postfix notation. Global properties of algorithmic languages. Laboratory projects. A knowledge of ALGOL is assumed. Also offered as MaSc 462. Prerequisite: Electrical Engineering 322.

Electrical Engineering 424. Computing Systems (3-0-3).

Advanced topics in computer organization including: arithmetic and nonarithmetic processing, memory utilization, storage management, addressing, control, and input-output. Comparison of specific examples of various solutions to computer system design problems. Prerequisite: Electrical Engineering 324.

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: Mathematical Sciences 380 or 381, Electrical Engineering 401.

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. Prerequisite: Electrical Engineering 460.

Electrical Engineering 462. Semiconductor and Quantum Electronic Devices (3-4-4).

This course is concerned specifically with the physical principles and operational characteristics of semiconductor and quantum electronic devices. Topics covered include theory of electronic conduction in semiconductors, theories of modern semiconductor junction, interface and bulk devices, lasers and related optical effects. Prerequisite: Electrical Engineering 460.

Electrical Engineering 490. 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).

The theoretical and practical aspects of network synthesis and filter design. Topics covered include: realizability, one-port synthesis, approximation methods, two-port synthesis and filter design and active filter synthesis.

Electrical Engineering 505. Advanced Electromagnetic Field Theory (3-0-3).

The mathematical techniques involved in field theoretical 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 electomagnetic 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 520. Systems Programming (3-3-4).

Review of batch process system programs, components, operating characteristics, user services and their limitations. Implementation techniques for parallel processing of input-output and interrupt handling. Overall structure of multiprogramming systems on multiprocessor hardware configuration. Details on addressing techniques, core management and file system. Traffic control, interprocess communication, design of system modules and interfacing system updating, documentation and operation. A knowledge of ALGOL is assumed. Also offered as MaSc 565. Prerequisite: Electrical Engineering 423.

Electrical Engineering 522. Automata and Formal Languages (3-0-3).

Introduction to recursive functions, formal systems and Turing machines. Godel numbering and unsolvability results, the halting problem and relative uncomputability. Grammars, Chomsky and Greibach Normal Form, pushdown automata, linear bounded automata, operations on languages, LR(K) grammars, stack automata and decidability. Also offered as MaSc 563. Prerequisite: Electrical Engineering 422.

Electrical Engineering 523. Switching Theory (3-0-3).

Combinational gate networks; synchronous and asynchronous sequential networks, faul detection and location in gate networks, the structure of sequential machines, and linear sequential machines. Also offered as MaSc 561. Prerequisite: Electrical Engineering 422 and 324.

Electrical Engineering 524. Non-numeric Programming (3-3-4).

Survey of statistical and heuristic techniques useful in modeling problems in learning and game playing. Methods of simulating cognitive processes. Application of non-numeric languages as SNOBOL 4 and LISP 1.5 to artificial intelligence. Discussion of tree and graph traversal algorithms. Papers from the current literature. Recommended: Electrical Engineering 423 and Mathematical Sciences 381. Also offered as MaSc 567.

Electrical Engineering 531. Digital Filtering (3-0-3).

This course will be on digital filtering and signal processing. Topics discussed will include sampling, quantization and signal representation, Z transform methods, recursive and non-recursive filters, frequency and time domain approaches, the Fast Fourier Transform and other topics of special interest to the students. Part of the course will be by lecture and part a discussion of various papers. Computer time will be available for problem working. Prerequisites: Electrical Engineering 401.

Electrical Engineering 532. Signal Theory (3-0-3).

A study of signals; their representation and design. Development of approximation theory. Relations between analog and digital signal processing. Representation of signal classes including the concepts of n-widths, e-entropy, and principal components. Prerequisites: Electrical Engineering 401.

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 560. 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 Msci 649.

Electrical Engineering 561. 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 Msci 648.

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.

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. Prerequisites: An intoductory backgound 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, Materials Science 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 follows 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 superconductivity will be presented. Prerequisite: EE 563 or equivalent. Also listed under same number in Departments of Chemistry, Materials Science 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, Materials Sciences 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, Materials Science 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, Materials Science and Physics.

Electrical Engineering 580. Physiology—Biophysics I (3-0-3).

A basic course in the life sciences stressing the analytical approach to the study of living systems. Emphasis will be on the mechanisms of nerve, muscle and receptor, and how these are usefully combined in vertebrate organisms. Specific topics include: Electrophysiological properties of the membrane of the neuron and muscle fiber; synaptic transmission; potentials in volume conductors arising from bioelectric sources; the structure and transducer properties of receptors; the pathways and nature of signals in the central nervous system; and an intoduction to the visual and auditory systems. Concurrent registration in E.E. 590 recommended for bioengineering students.

Electrical Engineering 581. Physiology—Biophysics II (3-0-3).

An introduction to several large-scale regulatory and control processes within the body, such as the cardiovascular and respiratory systems, water balance, and the vestibular and oculomotor systems. Considerable emphasis will also be placed on the detailed anatomy and function of such organs as the heart, the lung, and the kidney.

Electrical Engineering 582. Bioengineering Instrumentation and Techniques (3-3-4).

A survey of components, systems and experimental methods related to bioengineering. Topics include: Transducers of bioelectric events; recording electrodes; applications of electronics; computer applications; and examples of instrumentation in specific systems. Emphasis will be placed on demonstrations and student participation in the laboratory. Prerequisite: Electrical Engineering 580.

Electrical Engineering 590. Projects (Credit to be arranged).

Theoretical and experimental investigations under staff direction.

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 and Electrical Engineering 420.

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: Electrical Engineering 461 and 505.

Electrical Engineering 680. Physiological Systems (3-0-3).

Application of control theory and systems analysis to the modeling and simulation of complex biological control and regulatory processes. Individual research projects are emphasized.

Electrical Engineering 681. Neural Systems (3-0-3).

Advanced topics in the electrophysiology and modelling of the neuron as a functional unit of the nervous system, with extension to the properties of neuronal assemblies. Specific topics include: Electrophysiology of the individual neuron and of certain neural systems models system pattern recognition and feedback in the nervous system and probabilistic models of neural systems. Prerequisite: Electrical Engineering 580.

Electrical Engineering 682. Volume Conductor Fields in Electrophysiology (3-0-3).

Analysis of various problems in the area of electrophysiology according to the principles of electromagnetic field theory. Topics include characterization of bioelectric sources, field-thoretic aspects of the activity of nerve and muscle, theoretical and electrophysiological aspects of electrocardiography and electroencephalography.

Electrical Engineering 683. Cardiovascular Dynamics (3-0-3).

Analysis of the properties and functions of the cardiovascular system including a detailed study of hemodynamics; mechanics of the heart; regulation of blood pressure, heart rate and myocardial contractility. Mathematical modeling techniques applicable to the cardiovascular system, as well as circulatory-assist and total replacement prosthetic devices will be discussed.

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;* Professors Akers and C. H. Ward
Associate Professor Leeds
Assistant Professor Characklis

The Undergraduate Program. General requirements for undergraduate science and engineering programs are given on pages 62-63. The major in Environmental Science and Engineering is intended for those students wishing to obtain academic training oriented toward the solution of technical environmental problems. The introductory courses 301a and 302b are intended for both majors and nonmajors. Humanities majors are encouraged to consider these courses for science distribution requirements. A complete list of courses required by the department is available from the Environmental Science and Engineering Advisor in each college or from the Departmental office, 102 Mechanical Lab. General requirements during the first two years include: two years of mathematics, two years of chemistry, one year of physics and one year of biology. Specific courses to satisfy these requirements vary somewhat and should be determined in consultation with a Department Advisor. Eight Environmental Science and Engineering or approved advanced technical courses are required during the Junior and Senior years. A list of suggested electives in various fields of science, engineering, humanities, and social science is available for students desiring additional guidance or specialization. The undergraduate curriculum has been designed with maximum flexibility and minimum specific requirements to encourage interdepartmental or double majors with all other fields of science and engineering.

Successful completion of the four year curriculum qualifies the student for the Bachelor of Arts degree with a major in Environmental Science and Engineering. Upon application the student may be admitted to a fifth year of specialized study leading to the degrees of Master of Environmental Sciences and Master of Environmental Engineering. These are the recognized professional degrees in the environmental field and are differentiated based on science or engineering orientation. Outstanding students wishing to pursue careers in teaching and research are qualified for graduate study after the B.A. degree.

The Graduate Program. The graduate program in Environmental Science and Engineering is an interdepartmental activity and offers the Master of Science and Doctor of Philosophy degrees. Applicants for admission to this interdisciplinary 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 Department 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 109-110.

The majority of courses taken by graduate students of Environmental Science and Engineering are those in other departments. 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

Environmental Science and Engineering 301a. Introduction to Environmental Systems (3-3-4).

The chemical, physical, and biological components of the environment as natural resources and the effects of pollution on their maintenance and utilization are introduced. The course includes a study of the sociologic, economic, political, legal, scientific, and engineering aspects of pollution and pollution abatement. Extensive use is made of case histories where considerable information is available. Instruction will involve student research seminars, extensive use of speakers working in the field, and field trips to observe and investigate the causes of pollution and current avenues open to solution of pollution problems.
Mr. Ward and Staff

Environmental Science and Engineering 302b. Resources Management (3-0-3).

The techniques used to plan and to regulate the use of environmental resources are studied. The relation between private and public allocations of resources and the processes of governmental regulations, including the impact of technology are illustrated with case studies. Emphasis is placed on definition and measurement of environmental quality and its relation to regulation of resources. *Mr. Leeds*

Environmental Science and Engineering 401a. Measurements in Environmental Systems (1-6-3).

The practice and theory of various analytical and instrumental techniques of measurement of the physical and chemical properties of air and water and their contaminants. The statistical precision and accuracy of all sampling and measurement procedures is emphasized. Laboratory and field studies prepare students to direct environmental quality surveys and to be involved in research requiring detailed knowledge of environmental sampling and measurement techniques. Emphasis is placed on the most reliable, modern techniques available.
Mr. Characklis and Staff

Environmental Science and Engineering 402b. Environmental Studies Projects (1-6-3).

Practical experience gained through involvement in studies of current environmental problems. Groups of students as study panels consider all aspects (social, political, economic, technical, etc.) of specific environmental problems of broad scope or individual students may elect indepth studies of selected topics. The results of studies will be presented in formal, written reports. In addition, training in the use of library resources will be emphasized in studying the problem.
Mr. Characklis and Staff

Environmental Science and Engineering 403a. Water Resources (3-0-3).

The operations and processes used in water and waste water treatment for accomplishment of a specified water quality objective are studied. Discussions emphasize basic physical, chemical and biological concepts with traditional approaches to process design serving as background material. *Mr. Busch*

Environmental Science and Engineering 404b. Introduction to Atmospheric Science (3-0-3).

The physical and chemical properties of the lower atmosphere, the movement of air masses, the transport of particulates and gases in the atmosphere, and the chemical reactions important to air resource management are studied. Problems in defining and measuring the quality of the atmosphere are considered as well as the problems of utilizing and conserving the atmosphere. *Mr. Few*

Environmental Science and Engineering 510a. Environmental Physiology and Toxicology (3-0-3).

The physical and chemical environment is studied as it affects the physiology and population dynamics of organisms (including man) and the stability and maintenance of biogeochemical cycles. Water and air pollutants are put in perspective in relation to other components of the environment. Not offered in 1971-72. *Messrs. Fisher, Hammond and Ward*

Environmental Science and Engineering 510b. Environmental Physiology and Toxicology (3-0-3).

Continuation of Environmental Science and Engineering 510a. *Messrs. Fisher, Hammond and Ward*

Environmental Science and Engineering 520a. Environmental Engineering Processes (3-0-3).

The basic physical, chemical and biological processes pertinent to pollution and pollution control systems are studied. Not offered in 1971-72. *Mr. Akers*

Environmental Science and Engineering 520b. Environmental Engineering Processes (3-0-3).

Continuation of Environmental Science and Engineering 520a. *Mr. Akers*

Environmental Science and Engineering 536b. Synthesis of Water Quality Systems (3-0-3).

The synthesis of water and waste water treatment systems. Biological processes as applied to industrial waste treatment are emphasized. *Mr. Busch*

Environmental Science and Engineering 545b. Modeling in Design and Resource Management (3-0-3).

The development, verification, and use of models in design and resource management is studied. Particular emphasis is placed on testing of assumptions and modern model building techniques. The information and control mechanisms required to implement resource management are studied in relation to the modeling process. *Mr. Leeds*

Environmental Science and Engineering 600a. Seminar.

Environmental Science and Engineering 600b. Seminar.

Continuation of Environmental Science and Engineering 600a.

Environmental Science and Engineering 641a. Advanced Topics (3-0-3).

Discussion and interpretation of current literature and research relevant to the environmental sciences will be conducted in a seminar setting. Available only to graduate students. Topic for the fall of 1971 will be Experimental Design. This course is also listed as MaSc 641a. *Mr. Characklis*

Environmental Science and Engineering 641b. Advanced Topics (3-0-3).

Continuation of Environmental Science and Engineering 641a. *Staff*

Environmental Science and Engineering 645a. Problems in Environmental Planning (3-0-3).

The problem to be studied will be an important current problem of the environment. The students function as members of a consulting panel and prepare, as part of the course work, a joint report on the problem selected for investigation. Political, economic and social aspects of the problem will be considered, as well as scientific and technical details. Graduate students from other departments with an interest in environmental problems are invited to lend their expertise in the studies. *Staff*

Environmental Science and Engineering 645b. Problems in Environmental Planning (3-0-3).

Continuation of Environmental Science and Engineering 645a. *Staff*

Environmental Science and Engineering 650a. Research and Thesis.
For the Master of Science.

Environmental Science and Engineering 650b. Research and Thesis.
For the Master of Science. Continuation of Environmental Science and Engineering 650a.

Environmental Science and Engineering 700a. Research and Thesis.
For the Doctorate.

Environmental Science and Engineering 700b. Research and Thesis.
For the Doctorate. Continuation of Environmental Science and Engineering 700a.

Environmental Science and Engineering 750a. Nonresident Candidate for Degree only.

Environmental Science and Engineering 750b. Nonresident Candidate for Degree only. Continuation of Environmental Science and Engineering 750a.

Mechanical and Aerospace Engineering and Materials Science

PROFESSOR CHEATHAM, *Chairman;* PROFESSORS BECKMANN, BROTZEN, CHAPMAN, MIELE, ROBERTS AND WILHOIT
ASSOCIATE PROFESSORS BOWEN, MCLELLAN, RUDEE, W. F. WALKER AND WIERUM
ASSISTANT PROFESSORS HEBERT AND HUANG

Requirements for the degrees of Bachelor of Arts with a major in Mechanical Engineering or Materials Science and Master of Mechanical Engineering or Master of Materials Science are summarized on pages 65, 108. Representative courses and normal sequence of registration in courses during the student's undergraduate years are available from the department. By proper choice of electives in the senior and fifth years, the student can specialize in Aerospace Engineering as part of the Mechanical Engineering degree program.

After completing four years of his curriculum, the student receives a Bachelor of Arts degree with a major in Mechanical Engineering or in Materials Science. 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 or Master of Materials Science.

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 104-106. 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.

MECHANICAL AND AEROSPACE ENGINEERING COURSES

Mechanical Engineering 301. Mechanics of Deformable Solids (3-0-3).

An introduction to the mechanics of deformable bodies with emphasis on the mechanics of solids. Topics include cartesian tensors and field equations of continuum mechanics. Applications of the elementary theory of elasticity, energy methods, torsion theory, and the theories of failure in engineering design are illustrated by problems involving deformation and failure of beams, shafts, columns, cylinders, disks, plates and shells. Prerequisite: Engineering 211. *Mr. Cheatham*

Mechanical Engineering 302. Fluid Mechanics (3-0-3).

A basic course in introductory fluid mechanics. A brief coverage of hydrostatics is followed by the development of the fundamental equations of fluid mechanics. The majority of the course is devoted to incompressible fluid mechanics, including topics such as laminar and turbulent flow, internal flows, external flows, open channel flow, and fluid machines. A brief introduction to compressible flow is given. *Mr. Walker*

Mechanical Engineering 303. Introductory Aerodynamics (3-0-3).

A first course in incompressible aerodynamics. The basic aspects of incompressible flow about airfoils and other submerged bodies, for both laminar and turbulent flows, is covered. Lift and drag forces, for both inviscid and viscous cases, are discussed. An introduction to boundary layer theory is given as well as certain aspects of atmospheric mechanics. *Mr. Chapman*

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 Process Laboratory (0-3-1).

A laboratory providing practical experience in and observation of selected industrial production processes. Laboratory fee required.

Mechanical Engineering 402. Engineering Design (3-3-4).

Application of advanced topics of mechanics in engineering design. Topics include elasticity, thermoelasticity, viscoelasticity and plasticity with design considerations involving thermal stresses, creep, impact, anisotropic and laminated composite materials, indentation and extrusion. The finite-element method and techniques of experimental stress analysis are discussed. A design project is required. Prerequisite: Mech 301. *Mr. Cheatham*

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. Chapman*

Mechanical Engineering 406. Senior Laboratory I (0-3-1).

This course provides laboratory instruction in several disciplines of interest to senior mechanical engineering students. 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. Hebert, Merwin

Mechanical Engineering 407. Senior Laboratory II (0-3-1).

A continuation of Mechanical Engineering 406. Laboratory fee required. Also offered as Civil Engineering 492. *Messrs. Vann and Merwin*

Mechanical Engineering 411. Advanced Engineering Mechanics (3-0-3).

Continuation of Engineering 211 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. Wilhoit*

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 and materials science students in the year they are candidates for the Master of Mechanical Engineering or Master of Materials Science degree. *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.
Mr. Clark

Mechanical Engineering 511. Elements of Continuum Mechanics I (3-0-3).

A unified presentation of the concepts and general principles common to all branches of solid and fluid mechanics. Topics include tensor analysis, deformation and strain, stress, and selected examples of constitutive equations. *Mr. Cheatham*

Mechanical Engineering 512. Elements of Continuum Mechanics II (3-0-3).

A continuation of Mechanical Engineering 511. Topics include reference to modern constitutive theory, and brief accounts of thermoelasticity, viscoelasticity, plasticity and irreversible thermodynamics. *Mr. Bowen*

Mechanical Engineering 521. Energy Conversion Systems (3-0-3).

Applications of thermodynamics to the study of energy conversion systems of various forms, including internal combustion engines, gas turbines, jet engines, fuel cells, solar cells, and other new concepts. *Mr. Hebert*

Mechanical Engineering 525. Propulsion (3-0-3).

Applications of fluid dynamics thermodynamics, and chemistry to propulsion systems. A detailed treatment of thermochemical processes as applied to combustion is given. Detailed studies of nozzle performance, solid and liquid propellants, and the dynamics of propulsion is given. Jet engines, rocket motors, and propeller systems are discussed. *Mr. Walker*

Mechanical Engineering 526. Fifth Year Laboratory I (0-3-1).

Laboratory work in photoelasticity, heat transfer, and fluid mechanics, as well as an independent research project of the student's choice. Emphasis is given to student planning and expediting the experiments. Laboratory fee required. *Mr. Hebert*

Mechanical Engineering 527. Fifth Year Laboratory II (0-3-1).

A continuation of Mechanical Engineering 526. Laboratory fee required. *Mr. Hebert*

Mechanical Engineering 570. Vibrations (3-0-3).

Analysis of the behavior of discrete and continuous linear, mechanical vibrating systems. Approximate methods including Rayleigh-Ritz method and Galerkin method; integral formulation; and transform methods. Computer applications to eigenvalue problems for multi-degree-of-freedom systems. Prerequisite: Mech. 411. *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. Huang*

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 581. *Mr. Huang*

Mechanical Engineering 583. Stability and Control of Aircraft (3-0-3).

Stability derivatives. Static stability and control. General equations of nonsteady motion. Dynamic stability. Aircraft applications. Missile applications. *Mr. Huang*

Mechanical Engineering 584. Orbital Mechanics (3-0-3).

Two-body problem. Three-body problem. General n-body problem. Perturbation methods. Determination of orbits. Trajectories and missions for space flight. *Mr. Wilhoit*

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 591. Gas Dynamics (3-0-3).

An introductory course in gas dynamics dealing with the fundamentals of compressible flow. A thorough treatment is given to one-dimensional flows with area change, normal shocks, friction, and heat addition. An introduction is made to two-dimensional flows including oblique shocks. Prandtl-Meyer flow, and the method of characteristics. *Mr. Walker*

Mechanical Engineering 592. Advanced Aerodynamics and Gas Dynamics (3-0-3).

A detailed study of multi-dimensional gas dynamics including two- and three-dimensional shocks and characteristics, supersonic wing theory, and transonic flow. Subsonic, compressible, aerodynamics and small perturbation theory are also treated. *Mr. Walker*

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 (Variable credit).

Staff

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.

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, rigid body dynamics, 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 systems to 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 propogation 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 (3-0-3).

General analysis of stress and strain (in three dimensions) and stress-strain relations for an elastic continuum. Application is made to torsion and flexure of cylinders and to plane strain, plane stress, and generalized plane stress. The solution of two-dimensional problems by use of complex variables is discussed. The solution of three-dimensional problems by use of potentials and the use of integral transform methods is included. *Mr. Wilhoit*

Mechanical Engineering 626. Theory of Elasticity II (3-0-3).

The solution of two-dimensional problems by use of complex variables. The solution of three-dimensional problems by use of potentials. Energy theorems.

Mr. Wilhoit

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. Theoretical 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. *Mr. Cheatham*

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 at Civil Engineering 616. *Mr. Merwin*

Mechanical Engineering 654. Minimization of Functions (3-0-3).

Ordinary theory of maxima and minima. Analytical methods. Numerical methods. Gradient methods. Conjugate-gradient methods. Variable-metric methods. Quasilinearization methods. *Mr. Miele*

Mechanical Engineering 655. Minimization of Functionals (3-0-3).

Optimal control theory and calculus of variations in one independent variable. Analytical methods. Numerical methods. Gradient methods. Quasilinearization methods. *Mr. Miele*

Mechanical Engineering 656. Optimum Aerodynamic Shapes (3-0-3).

The theory of the calculus of variations is applied to the problems of optimum wings, fuselages, wing-fuselage combinations, and rocket nozzles at subsonic, supersonic, hypersonic, and free-molecular flow velocities The panorama of the subject is reviewed. Prerequisite: Mechanical Engineering 654. *Mr. Huang*

Mechanical Engineering 657. Optimum Trajectories (3-0-3).

The Meyer problem of the calculus of variations is reviewed. The theory is applied to the flight paths of aircraft, missiles, satellites, and spaceships. Prerequisite: Mechanical Engineering 654. *Mr. Huang*

Mechanical Engineering 670. Nonequilibrium Thermodynamics I (3-0-3).

Foundations of the thermodynamics of irreversible processes. Thermodynamics of various types of nonlinear materials such as materials with memory. Thermodynamic stability. Thermodynamics of diffusion and chemical reactions. *Mr. Bowen*

Mechanical Engineering 671. Nonequilibrium Thermodynamics II (3-0-3).

A continuation of Mechanical Engineering 670. *Mr. Bowen*

Mechanical Engineering 673. Advanced Hydrodynamics I (3-0-3).

Classical, inviscid, incompressible, fluid dynamics including potential theory, airfoil theory, submerged bodies, virtual mass, surface waves, and free streamline flows. *Mr. Hebert*

Mechanical Engineering 674. Advanced Hydrodynamics II (3-0-3).

This course is devoted to incompressible boundary layer theory. Both laminar and turbulent flows are treated as well as transitional flow. Classical, "exact," solutions and integral methods are employed. *Mr. Walker*

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. Chapman*

Mechanical Engineering 683. Radiative 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 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 studied. 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*

Mechanical Engineering 700. Research and Thesis for Non-Resident Students.

Graduate students who have completed all work for an advanced degree except certain examination and/or completion of a dissertation and are *not on campus* must register in this course during each semester as a non-resident ("degree candidate only") student.

MATERIALS SCIENCE COURSES

Materials Science 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, 210a, Chemistry 120a, b. Laboratory fee required.
Messrs. Brotzen, McLellan, Roberts, and Rudee

Materials Science 401a. Thermodynamics and Transformations in Alloys (3-0-3).

This is an introduction to the application of classical thermodynamics to systems of solid solutions and intermetallic compounds. The phase law and phase equilibrium are discussed in detail. Experimental methods for determining free energies in binary systems are also presented in detail.

Simple models for transformations of various kinds in solids are presented and correlated with experimental data on nucleation and grain growth. *Mr. McLellan*

Materials Science 402a. Mechanical Properties of Materials (3-0-3).

This course covers the basic, fundamental properties of dislocations in crystals at the advanced undergraduate level. Application of elementary dislocation theory to mechanical behavior such as creep, work hardening, internal friction and fracture will be described. Qualitatively, a description of the structure sensitive phenomena of crystals will be presented in the light of our understanding of point and line imperfections in solids. *Mr. Roberts*

Materials Science 403b. Physical Properties of Solids (3-0-3).

A survey of electrical, magnetic, and optical properties of metals, semiconductors and dielectrics. The discussion will be based on elementary concepts of band theory, which will be introduced in this course. *Mr. Brotzen*

Materials Science 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*

Materials Science 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*

Materials Science 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*

Materials Science 562. Advanced Metallurgical Laboratory II (0-4-1).

A continuation of Materials Science 561. Laboratory fee required.

Materials Science 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 Materials Science 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. *Mr. Rabson*

Materials Science 564. Electron Transport and Superconductivity (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follows Materials Science 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: Materials Science 563 or equivalent. Also offered as Chemistry 564, Electrical Engineering 564, Physics 564. *Mr. Brotzen*

Materials Science 565. Dielectric & Optical Properties of Matter (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follows Materials Science 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.

Materials Science 566. Imperfections & Mechanical Properties (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follows Materials Science 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: Materials Science 563 or equivalent. Also offered as Chemistry 566, Electrical Engineering 566 and Physics 566. *Messrs. Roberts and Estle*

Materials Science 567. Magnetism and Magnetic Resonance (3-0-3).

This course is one of the introductory graduate level courses on the solid state that follows Materials Science 563. The basis of the magnetic properties of solids will be discussed. This will include diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, and ferrimagnetism. The phenomen 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: Materials Science 563, or equivalent. Also offered as Chemistry 567, Electrical Engineering 567, and Physics 567. *Mr. Donoho*

Materials Science 604. Defect Structure of Synthetic and Biological Polymers (3-0-3).

Theory of disclinations in solids. Application of the theory to organic polymers. Liquid and Mobius crystals and insect muscle. It is helpful if the student has taken at least one of the following courses: MaSc. 402a, 566a or 694b. *Mr. Roberts*

Materials Science 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. Statistical mechanical models for solid solutions are presented. *Mr. McLellan*

Materials Science 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 solutions. Order-disorder transformation. Shear transformations. Transformations occurring in the heat treatment of iron alloys. *Mr. McLellan*

Materials Science 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: Materials Science 536. *Mr. Rudee*

Materials Science 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: Materials Science 402a or 566a. *Mr. Roberts*

Materials Science 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.

Materials Science 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 560a. *Mr. Bourne*

Materials Science 694. Polymer Science and Engineering (3-0-3).

Basic concepts in macromolecular chemistry and physics, and their application in the production, processing and use of synthetic polymers. (a) Polymer synthesis, physical chemistry, rheology and characterization. (b) Molecular organization of polymeric liquids, glasses and crystals, viscoelastic behavior and structure-property relations, processing techniques and applications of polymeric and composite materials. Also offered as Chemical Engineering 694a. *Mr. Armeniades*

English

PROFESSOR WARD, *Chairman;* PROFESSORS CAMDEN, DOWDEN, MEIXNER, PARISH, PIPER, SPEARS AND THOMAS

ASSOCIATE PROFESSORS BAKER, DOUGHTIE, GROB, HUSTON, ISLE, MCMURTRY, MINTER AND PATTEN

ASSISTANT PROFESSORS DOODY, IGLESIAS, KELLY AND MORRIS

Requirements for a Major in English: A minimum of twelve semester courses in English; eight semester courses must be advanced. It is strongly recommended that students planning to go on to graduate study in English complete two semesters of advanced courses in French, German, or Latin.

Requirements for the Degree of Master of Arts. Though no students are admitted who seek a terminal M.A. degree, Ph.D. candidates may take the master's degree if they wish. They are expected to pass six semester courses in English, including "Introduction to Graduate Study: Bibliography and Criticism," satisfactorily complete a thesis (of approximately fifty pages), and defend the thesis in an oral examination. The language requirement is to be satisfied either by the passing of a reading test or by the successful completion of a one-semester literature course offered by a foreign language department at Rice or another accredited institution.

Requirements for the Degree of Doctor of Philosophy. Candidates for the doctoral degree must successfully complete (or have completed before enrolling) two semester courses in the literature of a foreign language at the junior or senior level. The courses may be taken at Rice or another accredited institution and must be approved by the departmental graduate committee; if possible, the courses should directly relate to the student's period of specialization in English or American literature.

The student must complete a minimum of twelve semester courses in English. "Introduction to Graduate Study: Bibliography and Criticism" is the only course required of all new students.

Usually in the beginning of the sixth semester, the student takes the preliminary examinations, which consist of three three-hour examinations in fields other than that in which he chooses to write his dissertation and one four-hour examination in his field of specialization.

The remaining requirements are the completion of a dissertation (of approximately one hundred and fifty pages) which shall demonstrate the candidates capacity for independent work in either traditional scholarship or critical interpretation, and the passing of a final oral examination on the thesis and related fields. In order to receive continuing financial aid, a student must have his candidacy for the Ph.D. approved before the end of his sixth semester of graduate work at Rice. To secure such approval, the student must have completed three requirements: (1) foreign language courses, (2) preliminary qualifying examinations, (3) prospectus for dissertation, prepared in consultation with the prospective director and approved by the departmental graduate committee.

COURSES

English 100a,b. Critical Reading and Writing (3-0-3, each sem.).

Analysis and discussion of literary texts: poetry, drama, prose fiction. Students submit frequent essays. *Staff*

English 240a. Modern and Ancient Narrative in Prose, Verse, and Drama (3-0-3).

Classical and medieval literature in translation (Homer to the Renaissance). *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. *Mr. Baker and Mr. Grob*

English 270a,b. Aspects of Modern Literature (3-0-3, each sem.).

Examination of central ideas and forms in the poetry, fiction, and drama of the late nineteenth and twentieth centuries. The emphasis will be on English and American literature, but some study will be made of relevant continental literature (in translation). Specific topics and authors studied will vary from year to year. *Mr. Doody*

English 300a. English Drama from the Beginning to Marlowe (3-0-3).

The development of dramatic genres from the "quem quaeritis" to the 1950's in the light of medieval and classical traditions. *Mr. Huston*

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. Huston*

English 310a. Modern British Poetry (3-0-3).
A survey of British poetry from 1890 to date. (Limited to juniors and seniors.) *Mr. Spears*

English 320a. Approaches to Modern Drama (3-0-3).
Realism, naturalism, the "well-made" tradition. *Mr. Thomas*

English 320b. Approaches to Modern Drama (3-0-3).
The topic for Spring Semester, 1972, is Ibsen, Shaw and O'Neill. *Mr. Thomas*

English 325a. Conrad and His Contemporaries (3-0-3).
Conrad's major works and selected novels of Hardy and Ford. *Mr. Dowden*

English 325b. Twentieth-Century British Novels (3-0-3).
From Joyce and Lawrence to the present. *Mr. Meixner*

English 330a. Advanced Writing 3-0-3, each sem.).
The writing of essays, stories, plays and novels. *Mr. McMurtry*

English 340a. The English Novel in the Eighteenth Century (3-0-3).
From Defoe to Austen. *Mr. Iglesias*

English 340b. The English Novel in the Nineteenth Century (3-0-3).
From Austen to Hardy. *Mr. Patten*

English 350a, b. The Romantic Period (3-0-3, each sem.).
(Taught by Mr. Dowden in alternate years.) *Mr. Grob*

English 355a. Early Victorian Literature (3-0-3).
Poetry and non-fiction of the early Victorian period, concentrating on Tennyson, Browning, Mill, Carlyle, and Ruskin. *Mr. Patten*

English 355b. Middle and Late Victorian Literature (3-0-3).
Poetry and non-fiction prose of the middle and late Victorian period. Special attention will be given to Arnold, the Pre-Raphaelites and Hopkins, and to a brief survey of Victorian drama. *Mr. Patten*

English 360a. Restoration Literature (3-0-3).
A study of the prose, poetry and drama of the Restoration. *Mr. Iglesias*

English 366a. The Earlier Eighteenth Century (3-0-3).
The Augustan Age (1700-1740), with emphasis on Swift and Pope. *Mr. Piper*

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. *Mr. Piper*

English 370a. Edmund Spenser and the English Renaissance (3-0-3).
Not offered in 1971-72 ***Mr. Hutson***

English 370b. Survey of Sixteenth-Century Literature (3-0-3).
Non-dramatic literature from More through Shakespeare. Not offered in 1971-72. *Mr. Doughtie*

English 371a. The English Lyric Before 1700 (3-0-3).
The lyric as a genre; developments in convention and technique from the Middle Ages through Dryden. Not offered in 1971-72. *Mr. Doughtie*

English 371b. 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 375a, b. Late Nineteenth-Century and Early Twentieth-Century English Literature (3-0-3, each sem.).

Only 375a offered in 1971-72. *Mr. Thomas*

English 380a. Literature of the Renaissance (3-0-3).

Mr. Parish

English 380b. Milton and the Classical Tradition (3-0-3).

Mr. Parish

English 385a. Chaucer (3-0-3).

The *Romaunt of the Rose, Book of the Duchess, Troilus and Criseyde;* selections from the *Canterbury Tales*. Not offered in 1971-72. *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 389a. American Prose to 1860 (3-0-3).

Special attention is given to fiction. *Mr. Minter*

English 389b. American Prose 1860-1910 (3-0-3).

Special attention is given to fiction. *Mr. Isle*

English 391a. American Fiction 1910-1940 (3-0-3).

Mr. Ward

English 391b. American Fiction 1940 to the present (3-0-3).

Mr. Isle

English 392b. American Poetry since 1915 (3-0-3).

Mr. Minter

English 395a. Black Literature in America (3-0-3).

Mainly twentieth-century poetry, fiction, and autobiography. Not offered in 1971-72. *Mr. Isle*

English 398a. History of Literary Criticism to 1900 (3-0-3, each sem.).

Survey of Western man's awareness of literary art as it evolved through his most important and imaginative and theoretical works. *Mr. Morris*

English 400a, b. Shakespeare (3-0-3, each sem.).

A case study of certain of the comedies, histories, and tragedies, with lectures on the interpretation of these plays. (To be taught by Mr. Camden in alternate years.) *Mr. Houston*

English 404a, b. Honors Seminar (3-0-3, each sem.).

Open to juniors 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. (The instructors vary from year to year.) *Messrs. Minter and Patten*

English 440a. History of the English Language (3-0-3).

The structure of Modern English. Not offered in 1971-72. *Staff*

English 440b. History of the English Language (3-0-3).

Introduction to methods in historical linguistics via Old and Middle English (440a prerequisite). Not offered in 1971-72. *Staff*

English 450a. Studies in Literary Types (3-0-3, each sem.).

In 1971-72 this course will be concerned with the novel, and given in the fall semester only. In other years different types will be studied. The instructors will vary from year to year. *Mr. Isle*

English 480a, b. Directed Reading in English and American Literature (3-0-3, each sem.).

Independent study on special topics selected by the student. Offered only with the consent of individual instructors. Open only to juniors and seniors. *Staff*

NOTE: *Pro-Seminars are intended to acquaint graduate students with extensive areas in English and American literature. Seminars are designed for advanced students familiar with the period under study. The specific topic of each seminar changes from year to year; these courses may be repeated for credit.*

English 500. Topics in English and American Literary History.

Graduate research and thesis for the degree of Master of Arts. *Staff*

English 501a. Introduction to Graduate Study (3-0-3).

The first half of this course is designed to acquaint beginning graduate students with bibliographical guides, aids to research, and methods of preparing scholarly papers. The second half introduces the student to major contemporary critical approaches to literature. *Mr. Morris* and *Mr. Thomas*

English 503a. Pro-Seminar in Middle English Literature (3-0-3).

Mr. Kelly

English 505a. Pro-Seminar in Renaissance Non-Dramatic Literature (3-0-3).

Not offered in 1971-72. *Mr. Baker*

English 507a. Pro-Seminar in Renaissance Dramatic Literature (3-0-3).

Mr. Camden

English 510b. Pro-Seminar in the Restoration and 18th Century Literature (3-0-3).

Mr. Piper

English 512b. Pro-Seminar in Pre-Romantic and Romantic Literature (3-0-3).

Mr. Dowden

English 515b. Pro-Seminar in Victorian Literature (3-0-3).

Not offered in 1971-72. *Mr. Patten*

English 517b. Pro-Seminar in 20th-Century British Literature (3-0-3).

Mr. Meixner

English 520b. Pro-Seminar in American Literature to 1900 (3-0-3).

Not offered in 1971-72. *Mr. Ward*

English 522b. Pro-Seminar in 20th Century American Literature (3-0-3).

Not offered in 1971-72. *Mr. Minter*

English 525. Pro-Seminar in Literary Criticism (3-0-3).

Not offered in 1971-72. *Messrs. Dowden and Morris*

English 540a, b. Old English (3-0-3, each sem.).
Not offered in 1971-72. *Staff*

English 553b. Seminar in Middle English Literature (3-0-3).
Not offered in 1971-72. *Mr. Kelly*

English 555a. Seminar in 16th-Century Literature (3-0-3).
The topic for 1971-72 is Spencer. *Mr. Doughtie*

English 557b. Seminar in 17th-Century Non-Dramatic Literature (3-0-3).
Mr. Baker

English 558b. Seminar in Renaissance Drama, excluding Shakespeare (3-0-3).
Not offered in 1971-72. *Mr. Camden and Mr. Huston*

English 559b. Seminar in Shakespeare (3-0-3).
Mr. Camden

English 560a. Seminar in Restoration and 18th-Century English Literature, excluding Fiction (3-0-3).
Swift, Pope and Prior. *Mr. Spears*

English 561b. Seminar in the 18th-Century Novel (3-0-3).
Not offered in 1971-72. *Mr. Piper*

English 562b. Seminar in Pre-Romantic and Romantic Literature (3-0-3).
The topic for 1971-72 is Coleridge and Byron. *Mr. Dowden*

English 565a. Seminar in Victorian Literature, excluding Fiction (3-0-3).
Mr. Grob

English 566a. Seminar in the Victorian Novel (3-0-3).
Not offered in 1971-72. *Mr. Patten*

English 567a. Seminar in 20th-Century British Novel (3-0-3).
The topic for 1971-72 is the Bloomsbury Group: Forster, Woolf, Strachey and E. Bowen. *Mr. Meixner*

English 568a. Seminar in 20th-Century British Poetry (3-0-3).
Not offered in 1971-72. *Mr. Spears*

English 570a. Seminar in American Literature to 1900 (3-0-3).
Mr. Ward

English 572b. Seminar in Modern American Poetry (3-0-3).
The topic for 1971-72 is Hart Crane, Roethke and Lowell. *Mr. Spears*

English 573b. Seminar in Modern American Fiction (3-0-3).
Mr. Isle

English 575b. Seminar in Literary Criticism (3-0-3).
Not offered in 1971-72. *Mr. Morris*

English 577a. Seminar in Literary Types (3-0-3).
The Novel. *Mr. Isle*

English 580a, b. Directed Reading in English and American Literature (3-0-3, each sem.).

Staff

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
ASSOCIATE PROFESSOR CAMFIELD, *Acting Chairman*
ASSOCIATE PROFESSORS BADNER, CAMBLIN, HAVENS AND PARSONS
ASSISTANT PROFESSORS MCEVILLEY, OLIVER-SMITH, WINNINGHAM AND CHENEY
VISITING ASSISTANT PROFESSOR MACDOUGALL
LECTURERS BROWN, WARREN, WIDRIG AND BLUE
VISITING LECTURERS MCCARTY AND TATE

Requirements for a Major in Fine Arts.

A minimum of twelve semester courses including at least three courses in both the creative arts and the history of art. Double majors may take a minimum of ten semester courses, including at least three courses in both the creative arts and the history of art.

Foreign Language: A minimum of one year's study at the college level in any foreign language or in linguistics. Competency may be established by successful completion of the course or by examination. For students intending to take 300 or 400 level courses in the History of Art, a reading knowledge of French, German or Italian is often essential.

Students interested in further guidance in planning work for the degree should consult departmental faculty advisers.

INSTITUTE FOR THE ARTS

DOMINIQUE DE MENIL, *Director*

The Institute for the Arts sponsors exhibitions of international importance throughout the year, and publishes scholarly catalogs. Visiting lecturers, art historians and creative artists are invited to the campus under the auspices of the Institute. An evening film series of classical and important contemporary films is also a part of the program. Additional activities include the Print Club and the Art Associates, both of which are membership organizations open to students and faculty as well as to interested persons outside the University. For further information write to the office of the Director.

HISTORY OF ART AND ARCHITECTURE 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. *Staff*

History of Art 215a, 216b. Ancient Art (3-0-3, each sem.).

Egypt, the Middle East, Greece, and Rome. *Mr. Chillman*

History of Art 225a. The Art of Primitive Peoples (3-0-3).

A survey of the tribal arts of West Africa, the aboriginal peoples of the South Pacific, and the North American Indian. Emphasis on stylistic analysis and function of characteristic types. Consideration given to the origin of common form. *Mr. Badner*

History of Art 303a, 304b. World Mythology (3-0-3, each sem.).

A survey of primitive, Near Eastern, Far Eastern, Greek, Celtic and Germanic myths. Primary emphasis is on the origin and diffusion of myths, with attention to anthropological and psychological theory. The method is comparative. The connection of myths to religious ritual, iconography and architecture is investigated, as well as their connection to philosophical ideas and their appearances as literary products. Extensive readings in primary and secondary sources. Fall semester only. *Mr. McEvilley*

History of Art 305a, 306b. Greek Art (3-0-3, each sem.).

In the first semester, Aegean Art of the bronze age introduces the development of Greek painting, sculpture and architecture from its beginning to the end of the Archaic period. In the second semester this development is carried from the Early Classical period to the close of the Hellenistic period. Permission of the instructor is required to enroll in the second semester without having taken the first. Not given 1971-72. *Mr. Oliver-Smith*

History of Art 307a, 308b. Roman Art (3-0-3, each sem.).

A study of the painting, sculpture and architecture of ancient Rome from its roots in Etruscan art through the Republican and Imperial eras to its transformation in the Early Christian period. Not given 1971-72. *Mr. Oliver-Smith*

History of Art 309a. Late Antique and Early Christian Art (3-0-3).

The formal and stylistic transformation of Late Antique art and the gradual adaptation of this art to Christian content in the period from the third to the ninth century, primarily in the West. Particular emphasis will be placed on the establishment of the church form itself. *Mr. Widrig*

History of Art 310b. Byzantine Art (3-0-3).

An attempt to define the distinct character of the art of the Eastern Empire from the Age of Justinian to the fall of Constantinople in 1453. Sufficient consideration will be given to Eastern early Christian art to make meaningful its evolution into Byzantine style. Architecture, painting, mosaic and sculpture will be evaluated in accord with the importance each has in the development of the whole stylistic concept. *Mr. Widrig*

History of Art 312b. Early Medieval and Romanesque Art (3-0-3).

A survey of architecture, sculpture and painting in Western Europe from the early middle ages through the twelfth century. The course centers on the evolving form of the Medieval church and the relation of the other arts to that image. Offered in alternate years; to be given Spring 1972. *Mrs. Brown*

History of Art 319a, 320b. Gothic Art (3-0-3, each sem.).

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, not given 1971-72. *Mrs. Brown*

History of Art 325a. African Art (3-0-3).

The traditional tribal arts of sub-Saharan west Africa in the context of their cultures. Function and style areas stressed. Consideration given to common forms, their meaning and distribution. Not offered 1971-72. *Mr. Badner*

History of Art 336b. Oceanic Art (3-0-3).

A study of the art of the aboriginal peoples of Melanesia, Polynesia, Micronesia and Australia. Emphasis placed on stylistic analysis and function of objects within the context of each culture. Consideration given to the meaning, origin and diffusion of similar forms. Not offered 1971-72. *Mr. Badner*

History of Art 345a. Renaissance and Baroque Architecture (3-0-3).

Renaissance architecture considered as a conscious break with medieval modes, its stylistic and theoretical development, primarily in Italy, during the 15th, 16th and 17th centuries. *Mr. Widrig*

History of Art 346b. Modern Architecture (3-0-3).

A consideration of the origins of modern architceurc in the revival modes of the 18th and 19th centuries, followed by the new architecture of Richardson, Sullivan, Frank Lloyd Wright and others, then the International Style of Gropius, Mies, Le Corbusier and recent trends of the mid-20th century. Limited enrollment. *Mr. Widrig*

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 Art (3-0-3, each sem.).

A survey of European architecture, sculpture and painting from the beginning of the fifteenth century to the late sixteenth century. Not given 1971-72. *Mrs. Brown*

History 417a, 418b. Baroque and Rococo Art (3-0-3, each sem.).

A survey of European architecture, sculpture and painting from the late sixteenth century to the late eighteenth century. The continuation, criticism and transformation of Renaissance form and space together with the discovery of new possibilities. *Mrs. Brown*

History of Art 438b. Indian Art of North America (3-0-3).

The arts of the historic and pre-historic Indian cultures of the United States and Canada with special attention paid to the Southwest, The Northwest Coast and to the Alaskan Eskimo. Emphasis on formal analysis of types, meaning and function. Offered in 1971-72 and in alternate years. *Mr. Badner*

History of Art 448a. Pre-Columbian Art (3-0-3).

The pre-conquest art of Andean and Mexican high cultures concluding with that of the Inca and Aztec. Emphasis placed on stylistic analysis and origin of forms. Offered in 1971-72 and in alternate years. *Mr. Badner*

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. Nineteenth Century Art in Europe (3-0-3).

Major movements in European painting and sculpture are considered in the general sequence of their evolution from Neo-Classicism in the late 18th century through Romanticism, Realism, Impressionism and Post-Impressionism. Primary attention is accorded to France, although significant developments are examined in Germany, England, Spain and Italy. Not given Fall 1971. *Mr. Camfield*

History of Art 463b. Trends in Art since 1945 (3-0-3).

A brief review of the primary European and American movements in 20th century art, followed by more thorough examination of recent trends. Abstract Expressionism, geometric abstraction, figurative art, "Neo-Dada", Op, Pop, Minimal Art, Assemblages and Happenings will be considered along with art critics and the problems of criticism. *Mr. Camfield*

History of Art 476a. Twentieth Century Art (3-0-3).

The revolutionary developments of modern painting and sculpture traced from their roots in Impressionism and Post-Impressionism through the innumerable "isms" of the 20th century—Fauvism, Cubism, Futurism, Supermatism, Constructivism, Dadaism, Surrealism, etc. Brief concluding attention to post-World War II developments. *Mr. Camfield*

History of Art 491-5. Special Topics (3-0-3).

Independent study or seminars concerned with various aspects of the history of art. Prerequisite: permission of instructor. *Staff*

History of Art 497a, 498b. Senior Thesis (1-0-1 first sem.; 3-0-3 second sem.).

An independent research course culminating with a thesis written under the direction of a member of the faculty. Enrollment is limited to art majors in their senior year, particularly those who plan to enter graduate school. Faculty approval a prerequisite for enrollment. *Staff*

CREATIVE ARTS

Art 205a, 206b. Photography I (1-6-3, each sem.).

Exploration of the basic materials and processes of the photographic medium. Admission by permission of the instructor. *Mr. Winningham*

Art 225a, 226b. Drawing I. (1-6-3, 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. Camblin, Parsons, Cheney and Tate

Art 301a, 302b. Three Dimensional Design (1-6-3, each sem.).

The visual vocabulary perceived through the organization of form and space, utilizing a variety of construction materials such as wood, plastic and cardboard. Open to all students. Not offered 1971-72. *Mr. Cheney*

Art 305a, 306b. Photography II (1-6-3, each sem.).

Problems in straight, documentary and experimental photography. Prerequisite: Photography I. Admission by permission of the instructor. *Mr. Winningham*

Art 325a, 326b. Drawing II (1-6-3, each sem.).

Advanced problems in drawing employing various media. Prerequisite: Drawing I. *Mr. Camblin*

Art 327a, 328b. Film Making I (1-6-3, each sem.).

A study of the expressive possibilities of the medium. Non-synchronous sound, using super eight millimeter film. Admission by permission of the instructor.
Messrs. Blue, McCarty and MacDougall

Art 329a, 330b. Film Form (1-6-3, each sem.).

Viewing, analysis and discussion of film classics. Admission by permission of the instructor. *Mssrs. Blue, McCarty and MacDougall*

Art 331a, 332b. New Media (1-3-6 each sem.).

Utilizes methods of artist and scientist, and is appropriate for a student in either field. Materials are obtained from natural and technological sources; various

contemporary processes such as vacuum forming and photo silkscreen printing are used. Heat, light, sound and motion may also be employed for expressive purposes.
Mr. Cheney

Art 401a, 402b. Advanced Design (1-6-3, each sem.).

Three dimensional constructions; kinetic sculpture; new media. Prerequisite: Art 301a, 302b or 331a, 332b. *Mr. Cheney*

Art 411a, 412b. Printmaking (1-6-3, each sem.).

Etching, lithography, and other printmaking methods both in black and white and in color. Prerequisite: Drawing I. *Mr. Tate*

Art 425a, 426b. Painting I (2-6-3).

Problems of painting, both traditional and experimental in various opaque media. Open to all students. Prerequisite: Drawing I or permission of instructor.
Mr. O'Neil

Art 427a, 428b. Film Making II (1-6-3, each sem.).

One major film project by each student. Production planning and the use of professional techniques, employing sixteen millimeter film and synchronous sound. Prerequisites: Film Making I. Admission by permission of the instructor.
Messrs. Blue, McCarty and MacDougall

Art 435a, 436b. Sculpture I (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 creative art with individual instruction and criticism. Admission by permission of department chairman and instructional staff. *Staff*

Art 465a, 466b. Sculpture II (1-6-3, each sem.).

Advanced problems in various media. Prerequisite: Sculpture I. *Mr. Parsons*

Art 475a, 476b. Painting II (1-6-3, each sem.).

Advanced problems in painting. Individual projects. Prerequisites: Painting I.
Mr. Ttate

THEATER

The Rice Players is an extra-curricular theater group composed of Rice students and faculty. The Players present at least four productions each year. Recent productions include: *The Lion in Winter, Marat/Sade, America Hurrah,* and *The Physicists.* The Players welcome participation by anyone interested in any aspect of theater production or management.

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 artists: director, actor and designer. *Mr. Havens*

French

Professor Bourgeois, *Chairman;* Professors Lecuyer, Raaphorst, Topazio and Wadsworth
Associate Professor Carrington
Visiting Professor Duployé
Assistant Professors Curtis, Nichols and Sobel

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. A minimum of ten advanced French courses is required for the major in French. However, only eight advanced courses are required for double majors or area majors. The following courses are required unless the student is exempted by his major advisor: French 311, 312, 390, and 392. Students are urged to take some work in European history, English or another European literature, or other courses closely related to French literature and culture. All majors and prospective majors must have their program approved by a representative of the department.

The French Department offers various courses conducted entirely in English which do not count toward a major in French or a double teaching major. These are French 225, 303, 304, 315, and 316. They may be accepted for an area major when approved by the departments involved.

An honors program in French is available to qualified students. French majors who have taken French 311 and 312 in their freshman or sophomore years are eligible to apply for admission to the program. For detailed information they should consult their French instructor or the department's advisor, Mr. Wadsworth.

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 Masters of Arts in French.

(a) Completion with high standing of a program approved by the department; normally this will include 24 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 preliminary written and oral examinations 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 54 hours of credit, including those required for the degree of Master of Arts. Six of these credit hours may be waived upon petition to the graduate faculty after the first year.
(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. Students have a choice between passing a preliminary examination in a second field of literature or taking one or two courses in a closely related field approved by the graduate faculty. If the student chooses to take two courses in such a "minor" field, only three (3) hours of credit will count toward the credit hours required for the Ph.D. NOTE: Requirements (b) and (c) must be fulfilled one 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. Curtis 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. Carrington*

French 201a, 202b. Intermediate French (3-0-3, each sem.).

Intensified review of French grammar with emphasis on oral practice, composition, and translation. An introduction to some main currents in modern French literature. *Mr. Carrington and Staff*

French 225a. French Society and Culture (3-0-3).

Social and cultural movements in France, from the Renaissance to the present day. Readings and discussion in English. Does not count toward a major in French. Open to freshmen. *Mr. Curtis*

French 303a. French Literature in Translation (3-0-3).

Study of selected masterpieces, mainly fiction, essays, and drama, from the Middle Ages to the end of the 18th century. Readings and class discussion in English. This course does not count toward a major in French.
Messrs. Carrington, Wadsworth and Mrs. Raaphorst

French 304b. French Literature in Translation (3-0-3).

Selected masterpieces of French literature, mainly fiction, essays, and drama of the 19th and 20th centuries. Readings and class discussion in English. This course does not count toward a major in French. *Mrs. Sobel, Messrs. Curtis and Lecuyer*

French 309. French Civilization (3-0-3).

A survey of French history and culture, to the end of the nineteenth century.
Mr. Curtis

French 309a. French Civilization (3-0-3).

A study of the development of French Culture. This course will focus on the historical, scientific, social and artistic achievements of the French to the end of the 19th century. This course is given in French. Prerequisite: Fr. 202 or placement exam. *Mr. Curtis*

French 310b. French Civilization (3-0-3).

A thorough study of the manners, culture, and institutions of contemporary France. This course is given in French. Prerequisite: Fr. 202 or placement exam.
Mr. Curtis

French 311a. Introduction to French Literature (3-0-3).

A study of the main currents in French literature from its beginning to the nineteenth century. Required for French majors. Recommended as background for higher numbered courses in French literature. Prerequisite: Fr. 202 or placement exam. *Mr. Raaphorst & Staff*

French 312b. Introduction to French Literature (3-0-3).

A study of the main current in French literature from the nineteenth century to the present. Required for French majors. Recommended as backgound for higher numbered courses in French literature. Prerequisite: Fr. 202 or placement exam.
Mrs. Raaphorst & Staff

French 315a. The French and European Novel (3-0-3).

A comparative literature course on French fiction of the nineteenth century with supplementary readings in other European novelists. Readings and discussion in English. Does not count toward a major in French. *Mr. Schwarz*

French 316b. The French and European Novel (3-0-3).

A continuation of French 315a. Comparative study of novelists from 1900 to the present. Readings and discussion in English. Does not count toward a major in French. *Mr. Schwarz*

French 318b. The Middle Ages and Renaissance (3-0-3).

A survey of the principal intellectual and aesthetic currents of the French Middle Ages and Renaissance with particular attention to Chrétien de Troyes, Villon, Rabelais, the Pléiade, and Montaigne. Pre-requisite: French 311a. To be given in 1971-72. *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. Prerequisite: French 311. *Mrs. Wadsworth*

French 322b. The Seventeenth Century (3-03).

French writers of the classical period, notably Molière, La Fontaine, La Rochefoucauld. Racine, Boileau, La Bruyère, and Mme. de La Fayette. Prerequisite: French 311. *Mrs. Wadsworth*

French 331a. The Eighteenth Century (3-0-3).

Montesquieu, Voltaire, Diderot, Rousseau, Beaumarchais; also other selected authors. Prerequisite: Fr. 311, 321 and 322. *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 Chateaubriand, Constant, George Sand, Stendhal, Balzac and the poetic works of Lamartine, Hugo, Vigny and Musset. Class analysis of texts and essays in French. To be given in 1971-72. *Mrs. Sobel*

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, Musset, Scribe, Dumas Fils, Augier, Becque, Curel, and Rostand. Analysis of texts and essays in French. To be given in 1972-73. *Mrs. Sobel*

French 390b. French Composition (3-0-3).

Translation from English into French and exercises in French composition. Conversation practice on various topics. Required for French majors. Prerequisite: Fr. 202 or placement exam. *Mr. Curtis*

French 392a. 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. Required for French majors. *Mr. Urrutibeheity*

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.

French 451b. Nineteenth Century Poetry: Parnassians and Symbolists (3-0-3).

This course traces the development of the poetic movement through the works of Gautier, Baudelaire, Leconte de Lisle, Hérédia, Verlaine, Rimbaud, and Mallarmé. Prerequisite: French 311 or 312 or 351. *Mrs. Raaphorst*

French 452b. French Realism and Naturalism (3-0-3).

A study of significant novels by Champfleurz, Duranty, Flaubert, Maupassant, Zola, Daudet, and the Goncourt brothers. Discussions and essays in French. Not offered in 1971-72.

French 481a. Modern French Drama (3-0-3).

A study of significant plays of Giraudoux, Cocteau, Anouilh, Montherlant, Sartre and Ionesco. Detailed study, discussion, and written analysis in French. Prerequisite: French 311 or 312. *Mr. Lecuyer*

French 482b. 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. Not offered in 1971-72. *Mr. Lecuyer*

French 483b. Twentieth Century French Literature (3-0-3).

A study of representative poets and prose writers of twentieth century France, and of cubist, surrealist and existentialist movements. Prerequisite: French 311 or 312 or 482. *Mr. Lecuyer*

French 488b. 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. Not offered in 1971-72. *Mr. Lecuyer*

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. Not offered in 1971-72.

French 517a. Seminar in Renaissance Literature (3-0-3).

The topic will change from year to year; may be repeated for credit. Not offered in 1971-72. *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 1971-72 will be Late Medieval and Early Renaissance Poetry. Prerequisite: French 411 or instructor's permission. *Mr. Carrington*

French 526b. 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 1971-72 will be Boileau and La Fontaine. *Mr. Wadsworth*

French 527a. Seminar on Classical Drama (3-0-3).

The topic will change from year to year; may be repeated for credit. The topic for 1971-72 will be Molière. *Mr. Wadsworth*

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 1971-72 will be Voltaire. *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. Not offered in 1971-72. *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 1971-72 will be Balzac (his provincial novels). *Mr. Bourgeois*

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 1971-72 will be Balzac (his Parisian novels). *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 1971-72 will be Peguy and his time: Les Cahiers de la Quinzaine. *Mr. Duployé*

French 571b. 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 1971-72 will be Huysmans: From Naturalism to Symbolism. *Mr. Duployé*

French 572a. 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 1971-72 will be Proust. *Mrs. Raaphorst*

French 577a. Seminar in Contemporary Literature (3-0-3).

The topic will change from year to year; may be repeated for credit. The topic for 1971-72 will be The Avant-garde Theater. *Mr. Lecuyer*

French 578b. Seminar in Contemporary Literature (3-0-3).

The topic will change from year to year; may be repeated for credit. The topic for 1971-72 will be the New Novel. *Mr. Lecuyer*

French 579. Studies in French Poetry (3-0-3).

Problems of versification, imagery, and literary analysis. Not offered in 1971-72. *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. Not offered in 1971-72. *Mr. Lecuyer*

French 595. Special Topics in French Literature (3-0-3).

In very rare cases, on the recommendation of the graduate French faculty, a candidate in his last year on the campus may be allowed to take this course to fill a particular lacuna. *Staff*

French 600. Graduate Research.

Graduate research and dissertation in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

French 700. Nonresident Research.

Geology

Professor Rogers, *Chairman;* Professors Adams, Burchfiel, De Bremaecker, Heymann and J. L. Wilson
Associate Professors D. R. Baker, Clark and Lankford
Assistant Professors Avé Lallemant, Powell and Warme
Lecturer Nettleton

In January 1952 Olga Keith 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.

Undergraduate Requirements. The following courses are required for completion of the degree of Bachelor of Arts with a major in Geology:

Geology 101a, 111a, 221a
Geology 102a, 112b, 222b

The above courses constitute a one-year sequence in introductory geology and are five credit hours per semester. They need not be taken concurrently although it is advisable to do so.

Geology 311a
Geology 312b
Geology 331a
Geology 332b
Geology 390a, b
Geology 401a

Any three of the following:

Geology 402b
Geology 405a
Geology 412b
Geology 417a
Geology 441a
Geology 455a, 456b
Geology 551a, 552b
Or one or more courses of special interest, possible at 500 level, by petition or recommendation of advisor

Total Geology courses: 12

The following supporting courses are also required:

Math 101a, 102b or equivalent (not 107a, 108b)
Chemistry 120a, b
Physics 100a, b (not 101a, b)
Two additional semester courses in math, science or engineering

Total courses: 20

The Department of Geology offers an approved curriculum leading to certification in Earth Science as a second teaching field. The geology curriculum consists of twenty-five semester hours of introductory courses which would most benefit a secondary school teacher, i.e., physical and historical geology; study of minerals, rocks and fossils; sedimentary processes; and a three-week field course.

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 specialities 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:

(1a) For the M.A. degree satisfy the language requirement by having (a) reading knowledge of one approved foreign language or (b) one skill or knowledge—such as knowledge of computer language—of a subject not within the immediate scope of the thesis work or departmental studies and
(1b) For the Ph.D. degree satisfy the language requirement by having (a) dictionary reading knowledge of two approved foreign languages; (b) knowledge of one language in depth; or (c) dictionary reading knowledge of one language and one skill or knowledge of a subject not within the immediate scope of the thesis work or departmental studies.
(2) Complete at a high level an approved program in geology and related subjects.
(3) Pass during first year of residence a basic examination in geology. At a later date a Ph.D. qualifying examination is required of all doctoral candidates. This is administered by the thesis committee.
(4) Complete for publication a thesis which represents an original contribution to the science.
(5) Defend orally the research work and conclusions of the thesis.

(6) Engage in some laboratory instruction, regardless of type of appointment.

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 101a. The Earth (3-0-3).

A study of the basic features of the Earth, the processes that have formed and are continuing to affect it and man's use of it. Topics include the nature and origin of rocks, the nature of the Earth's interior and processes on and near the surface. Special attention will be paid to the geologic factors that influence problems of over-population, utilization of raw materials and control of the environment. *Messrs. Rogers and Heymann*

Geology 102b. Heritage of the Earth (3-0-3).

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. Prerequisite: Geology 101a or consent of the department. *Mr. Warme*

Geology 111a. Laboratory Study of the Earth (0-3-1).

Identification of rocks and minerals, interpretation of maps and practical investigations of current geologic problems. Accompanies Geology 100a. Laboratory fee required. *Messrs. Rogers and Heymann*

Geology 112b. Laboratory for Heritage of the Earth (0-3-1).

Analysis of geologic maps with emphasis on the structure of stratified rocks and their organic contents. Accompanies Geology 101b. Laboratory fee required. *Mr. Warme*

Geology 221a. Topics in Introductory Geology (1-0-1).

Accompanies Geology 100a and provides more complete examination of the basic concepts of physical geology. *Messrs. Rogers and Heymann*

Geology 222b. Topics in Introductory Geology (1-0-1).

Accompanies Geology 102b and provides more complete examination of the basic concepts of historical geology. *Mr. Warme*

Geology 311a. Mineralogy (3-3-4).

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. Powell*

Geology 312b. 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. Laboratory fee required. *Mr. Powell*

Geology 321a. 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. Prerequisite: consent of the department. *Mr. Adams*

Geology 322b. 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 331a. Structural Geology (3-3-4).

Introduction to structural geology and field methods. Topics covered include description 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. Burchfiel*

Geology 332b. 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. *Staff*

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.

Geology 401a. Stratigraphy and Advanced Historical Geology (3-3-4).

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. Laboratory fee required. *Mr. Wilson*

Geology 401b. Invertebrate Paleontology (3-3-4).

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 taxonomy. Laboratory fee required. *Mr. Warme*

Geology 412b. Igneous and Metamorphic Petrology (3-3-4).

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 311a, 312b. Laboratory fee required. *Messrs. Rogers, Baker and Avé Lallemant*

Geology 441a. Introduction to Geophysics (3-3-4).

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, 456b. Geochemistry (3-3-4, each sem.).

A study of the geologic 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. Laboratory fee required. *Mr. Adams*

Geology 481a, 482b. Research in Geology.

Advanced work adapted to the needs of the individual student. Credit variable. Laboratory fee required. *Staff*

Geology 491a, 492b. 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. *Staff*

Geology 501a, 502b. 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. Laboratory fee may be required. *Staff*

Geology 504b. Environmental Stratigraphy (3-4-4).

Principles of stratigraphy and stratigraphic analysis are taught through analysis of various depositional environments. Each of the major types of sediments is related to a paleotectonic framework in an attempt to ascertain the controls exercised by tectonics, geography and climate in the formation of rock strata. Prerequisites: Stratigraphy (Geology 401a or equivalent), Sedimentary Petrology (Geology 537a) taken concurrently or previously. Laboratory fee may be required. *Mr. Wilson*

Geology 506b. Carbonate Geology (3-3-4).

The study of recent carbonate sediments and the depositional environments and the application of such principles to the interpretation of ancient carbonate strata. Laboratory fee may be required. *Mr. Wilson*

Geology 511a-528b. Seminars in Geology.

Courses covering the subjects listed in sequence under geology research courses numbered 581a through 598b. Individual seminars may cover different topics in different years and may be taken more than once. All seminars three units per semester. *Staff*

Geology 531a, 532b. Geophysics (3-3-4, 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 may be required.
Messrs. De Bremaecker and Clark

Geology 534b. Crust and Upper Mantle (3-3-4).

Discussion of geophysical data concerned with problems of the crust and upper mantle. Topics will include the crust-mantle interface, continental margins, active tectonic areas and sea floor spreading. Laboatory fee may be required. *Mr. Clark*

Geology 536b. Organic Geochemistry (3-0-3).

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; the nature, distribution and origin of organic substances in sediments and sedimentary rocks; and the use of constituents for deciphering the physical, chemical and biological history of rocks. *Mr. Baker*

Geology 537a. Advanced Sedimentary Petrology (3-3-4).

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. Laboratory fee may be required. *Mr. Baker*

Geology 538b, 539b. Advanced Topics in Petrology (3-0-3, each sem.).

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 vary from year to year. *Mr. Rogers*

Geology 551a, 552b. 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. Special attention will be given to the chemistry of seawater. Laboratory fee may be required. *Mr. Heymann*

Geology 555a. Advanced Topics in Geochemistry (3-3-4).

A study of selected topics, particularly geochronology, radiometry, isotope and trace element analysis and interpretation. Laboratory fee may be required. *Mr. Adams*

Geology 556a. Radiogeology (3-3-4).

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 theory and practice. Gamma spectrometry in the field is also included. The biological and health aspects of the radiation environment are discussed. Laboratory fee may be required. *Mr. Adams*

Geology 561a, 562b. Advanced Topics in Geophysics (3-3-4, each sem.).

Study of selected topics in geophysics, including seismology, gravitation, and geomagnetism. Laboratory fee may be required. *Messrs. De Bremaecker and Clark*

Geology 563a, 564b. 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. Laboratory fee may be required. *Messrs. Burchfiel and Avé Lallemant*

Geology 566b. Experimental Structural Geology (2-3-3).

Selected topics, as elesticity and plasticity of minerals and rocks. Laboratory work includes experimental rock deformation. Prerequisite: Geology 563a. Laboratory fee may be required. *Mr. Avé Lallemant*

Geology 568b. Fabric Analysis (2-3-3).

Studies of microstructures, textures and petrofabrics of deformed rocks, stress and strain analysis. Laboratory fee may be required. *Mr. Avé Lallemant*

Geology 577a. Planetary Physics and Lunar Geology (3-0-3).

Studies of the solid objects in the solar system. Mechanical and thermal aspects of planetary interiors. Observations of planetary surfaces with special emphasis on observations from man-made satellites. *Mr. Powell*

Geology 578b. Planetary Physics and Lunar Geology (3-0-3).

A continuation of 577a; however, 577a is not a prerequisite. Topics include meteorites and tektites, geology of the moon and Mars. These topics will be synthesized in planetary models and theories concerning the origin of the terrestrial planets and satellites. *Mr. Heymann*

Geology 581a, 582b. Research in Physical and Structural Geology (0-9-3).

Messrs. Burchfiel, De Bremaecker and Avé Lallemant

Geology 583a, 584b. Research in Mineralogy (0-9-3).

Staff

Geology 585a, 586b. Research in Petrography and Petrology and in Carbonate Geology (0-9-3).

Messrs. Baker, Rogers, Wilson and Powell

Geology 587a, 588b. Research in Geochemistry and Meteoritics (0-9-3).
Messrs. Adams, Baker, Heymann and Powell

Geology 589a, 590b. Research in Geophysics (0-9-3).
Messrs. De Bremaecker and Clark

Geology 591a, 592b. Research in Invertebrate Paleontology and Stratigraphy (0-9-3).
Messrs. Lankford, Warme and Wilson

Geology 593a, 594b. Research in Economic and Petroleum Geology (0-9-3).
Staff

Geology 595a, 596b. Research in Regional Geology (0-9-3).
Staff

Geology 597a, 598b. Research in Marine Geology (0-9-3).
Staff

Germanics

PROFESSOR VON DER MEHDEN, *Acting Chairman*
ASSOCIATE PROFESSORS COPELAND, LOCKEMANN AND J. B. WILSON
VISITING ASSOCIATE PROFESSORS MOLLENAUER AND WEISSENBERGER
ASSISTANT PROFESSORS SCHUBERT, SOUDEK AND WINKLER

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 a final oral examination on the thesis and related topics.

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 eighteen 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.).

Introductory German with emphasis on audio-lingual and reading skills. Language laboratory work required. *Mr. Copeland and 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. *Mr. Soudek and Staff*

German 201b. Intermediate German (3-1-3). *Staff*

German 202b. Intermediate German: Scientific (3-0-3).

The course emphasizes readings in scientific German. Prerequisite: 201a. *Staff*

German 204a. Intermediate German (3-0-3). *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. Not offered in 1971-72. *Mr. Wilson*

German 302b. Advanced Scientific German (3-0-3).

The continuation of the above. Prerequisite: 301a or permission. Not offered in 1971-72. *Mr. Wilson*

German 305a. Composition and Conversation (3-0-3).

The work will be based on literary texts. Required of German majors. *Mr. Schubert*

German 306b. Composition and Conversation (3-0-3).

The continuation of the above. Prerequisite: 305a. Required of German majors. *Mr. Schubert*

German 321a. Nineteenth-Century Dramatists (3-0-3).

The course emphasizes the works of Grillparzer, Büchner, and Hebbel. Offered in alternate years: not offered in 1971-72. *Staff*

German 322b. Twentieth-Century Dramatists (3-0-3).

The course emphasizes the works of Wedekind, Brecht, and Dürrenmatt. Offered in alternate years: not offered in 1971-72. *Staff*

German 331a. Survey of German Literature (3-0-3).

From the beginnings until the eighteenth century. Offered in alternate years: given in 1971-72. Required of German majors. *Mr. Soudek*

German 332b. Survey of German Literature (3-0-3).

From the eighteenth century to the present. Offered in alternate years: given in 1971-72. Required of German majors. *Mr. Soudek*

German 341a. Romanticism (3-0-3).

Offered in alternate years. *Staff*

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 1971-72. *Mr. Mollenauer*

German 381a. German Literature since 1900 (3-0-3).

The course deals chiefly with poetry of Rilke, George, and Benn. Offered in alternate years: given in 1971-72. *Mr. Weissenberger*

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 1971-72. *Mr. Weissenberger*

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 403a. Advanced Grammar and Stylistics (3-0-3).

The course deals with problems of composition and translation. Required of German graduate students. Not offered in 1971-72. *Mr. Winkler*

German 404a. Introduction to Germanic Linguistics (3-0-3).

The course treats introductory linguistic concepts and aspects of German phonology and syntax in an historical perspective. Required of German graduate students. *Mr. Copeland*

German 421a. German Literature of the Renaissance and Reformation (3-0-3).

Offered in alternate years: not offered in 1971-72. *Staff*

German 422b. German Literature of the Baroque (3-0-3).

Offered in alternate years: given in 1971-72. *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 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 1971-72: History of the German Language. *Mr. Copeland*

German 505b. Seminar in Eighteenth Century Literature (3-0-3).

The topics will change from year to year: may be repeated for credit. The topic in 1971-72 will be Schiller. *Mr. Winkler*

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.

German 509a. Seminar in Bibliography, Research Problems, and Literary Theory (3-0-3).

The course treats problems in bibliography and literary research. Required of German graduate students. *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. Required of German graduate students. Not offered in 1971-72. *Mr. Winkler*

German 511a. Old Saxon (3-0-3).

Offered in alternate years: given in 1971-72. *Mr. Wilson*

German 512b. Old Icelandic (3-0-3).

Offered in alternate years: given in 1971-72. *Mr. Wilson*

German 521a. Gothic (3-0-3).

Offered in alternate years: not offered in 1971-72. *Mr. Wilson*

German 522b. Old High German (3-0-3).

Offered in alternate years: not offered in 1971-72. *Mr. Wilson*

German 541a. Linguistic Structure of German (3-0-3).

Offered in alternate years: not offered in 1971-72. *Mr. Copeland*

German 551a. Seminar in Modern Literature (3-0-3).

Literary problems of the early twentieth century. Offered in alternate years. Given in 1971-72. *Mr. Weissenberger*

German 553a. Literary Genres (3-0-3).

Mr. Lockemann

German 554b. Literary Genres (3-0-3).

Mr. Lockemann

German 560a. Seminar in Romanticism (3-0-3).

The topics will change from year to year: may be repeated for credit. To be given in 1970-71. *Mr. Koepke*

German 581a. Seminar on Lessing (3-0-3).

Offered in alternate years: not offered in 1971-72. *Mr. Winkler*

German 600a, b. Graduate Research.

Graduate research and dissertation in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Courses in Comparative Literature

Germanics 261a. German Literature in Translation (3-0-3).
Not offered in 1971-72. *Staff*

Germanics 262b. German Literature in Translation (3-0-3).
Not offered in 1971-72. *Mr. Winkler*

Germanics 361a. Special Topics in Modern German Literature (3-0-3).
Mr. Winkler

Germanics 362b. Special Topics in Modern German Literature (3-0-3).
Mr. Winkler

Germanics 401a. Arthurian Literature in the Middle Ages I (3-0-3).
The course will deal with the development of the Arthurian material from the earliest stages to the end of the twelfth century. The Welsh, Latin, French and German texts will be read in translation. Not offered in 1971-72. *Mr. Soudek*

Germanics 402b. Arthurian Literature in the Middle Ages II (3-0-3).
The course will cover the period from 1200 to 1500. The primary sources will be read in English translation. *Mr. Soudek*

Greek

(*See* page 153)

Health and Physical Education

PROFESSOR BEARDEN, *Chairman;* PROFESSORS HERMANCE AND POINDEXTER
ASSOCIATE PROFESSOR SPENCE
ASSISTANT PROFESSORS BARKER, BLAND AND CHARLTON
LECTURERS EGGERT, ELSON AND HAMPTON
INSTRUCTORS LEE AND ROBBINS

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 activities, and to familiarize the students with the physical education facilities and equipment available to them at Rice University. Two periods each week. Required of all freshmen and transfers without equivalent. *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. *Mrs. Poindexter*

Health and Physical Education 110b. Anatomy and Physiology (3-0-3).

An introductory course in human anatomy and physiology. Emphasis is on gross structure and basic concepts of function in man. *Mr. Spence and Elson*

Health and Physical Education 125a. Laboratory (0-3-1).

The following physical education activities are included in this course: handball, soccer and volleyball. For each activity a study is made of the history, educational values, skills and game formations, methods of teaching and coaching, court and field construction officiating, and audiovisual aids or laboratory fee required. *Mr. Bland*

Health and Physical Education 126b. Laboratory (0-3-1).

This course will teach interested students to become Water Safety Instructors. The classes will be in three phases: swimming, life saving and beginning swimming. Each phase includes skills, theory, teaching progressions and practice teaching. Laboratory fee required. *Mr. Bland*

Health and Physical Education 210a. 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. Laboratory (0-3-1).

The following physical education activities are included: badminton, archery, and tennis. For each activity a study 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 226b. Laboratory (0-3-1).

This course is an introduction to gymnastics. The following activities are included: tumbling, trampoline, parallel bars (men and women) side horse, vaulting, rings, and high bar. Included in each of these events is a study of progression of skills, history, and educational values, apparatus construction and care, lead-up stunts and skills, methods of teaching and coaching, and officiating. Laboratory fee required. *Mr. Hampton*

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 305a. Physical Education for Exceptional Children (3-0-3).

This course investigates the various areas of exceptionality displayed in children within the school setting, the management of the prescriptive education program, and the role of physical education within this program. Included is an analysis of current findings and programs for the gifted, the mentally retarded, the emotionally disturbed, the brain injured, visually and auditorially handicapped and orthopedically handicapped children. *Mr. Charlton*

Health and Physical Education 310b. Methods, Materials, and Curriculum Construction in Physical Education and Health Education, 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 311b. Motor Learning (3-0-3).

A study of the physiological and psychological elements of the perceptual motor learning process. Concentration is on the physical, mental, and personality factors underlying skill acquisition, skill development, and growth and development. *Mrs. Poindexter*

Health and Physical Education 320a. Tests and Measurements (3-0-3).

This course includes anthropometric measurements, cardiac function tests, athletic achievement tests, classification tests, motor ability and capacity, motor fitness tests, statistical methods and an introduction to computers. *Mr. Bearden and Hampton*

Health and Physical Education 321b. Physiology of Exercise (3-1-4).

A study of specific effects of exercise on physiologic function. Concentration is on the circulatory, respiratory and muscular systems. Included are techniques of measuring physiologic parameters related to exercise. Laboratory fee required. *Mr. Spence*

Health and Physical Education 325a. Laboratory (0-3-1).

Football and basketball are included in this course. 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. Laboratory fee required. *Mr. Bland*

Health and Physical Education 326b. Laboratory (0-3-1).

Track and baseball are included in this course. 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. Laboratory fee required. *Mr. Charlton and Bland*

Health and Physical Education 327a. Coaching and Officiating Team Sports for Women (0-3-1).

Laboratory experience designed to develop knowledge of scientific principles of advanced performance, competency of coaching techniques and mechanical analysis of skills. Individual concentration is on improvement of performance skills, teaching and coaching techniques of selected team sports for women. *Miss Lee*

Health and Physical Education 328b. Folk and Modern Dance and Field Sports for Women (0-3-1).

Laboratory experience designed to improve teaching competency of folk and contemporary dance and selected team and individual sports. *Miss Lee*

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 and school health program organization. *Miss Robbins*

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

Professor Drew, *Chairman;* Professors Higginbotham, Hyman, Lear, Matusow, Rath and Vandiver
Associate Professors Garside, Gruber and Loewenheim
Assistant Professors Kapp, Patterson, Stokes, Van Helden and Wiener
Visiting Assistant Professor Logan
Instructor Haskell

Undergraduate Majors. A student majoring in history must take a minimum of ten semester courses in history, of which six must be on the advanced level (i.e., 300's or 400's). It is advisable that students acquaint themselves not only with humanistic disciplines other than history (for example, literature, fine arts, and philosophy), but also with social sciences such as political science, sociology, economics, and anthropology whose contributions to historical studies are of increasing importance. Some foreign language proficiency is recommended for the potential traveler, researcher, or graduate student (most graduate schools require a reading knowledge of French and German for the Ph.D. degree).

Graduate Work in History. Graduate students in history are accepted for study leading to either the M.A. or Ph.D. 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 and European history. Further information about the fields may be obtained on request from the department.

Graduate fellowships as well as graduate scholarships within the limits of available funds are awarded on application to qualified students of demonstrated ability. Fellowships include a stipend and a waiver of tuition; scholarships provide only a waiver of tuition. Graduate fellows are expected to render limited services to the department. A number of graduate fellows are given the opportunity to gain experience in scholarly editing by working on the *Journal of Southern History,* the *Austrian History Yearbook,* or *The Papers of Jefferson Davis,* all 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. In addition to the courses mentioned above, each student is required to register in History 501a, 502b while writing his thesis. An oral defense of the thesis is also required. Completion of these requirements usually takes two years. Not more than three years may elapse between the time the student is admitted to graduate study and the completion of his degree, unless an extension is approved by the departmental graduate committee.

Requirements for the Ph.D. Candidates for the Ph.D. degree are expected to prepare themselves for a qualifying examination in four fields, at least two of which must be in the major area of concentration (either European or American history). If the major area is European history, then one field must be taken in American history; and if the major area is in American history, then one field must be taken in European history. The fourth field may be taken outside the department if approved by the departmental graduate committee. Preparation for this qualifying examination (the passing of which constitutes formal admission to candidacy for the degree) will normally include course work, seminars, directed reading, and a substantial amount of independent reading. The examination will usually be oral, though it may be written or both at the discretion of the department. It is given only after the student has completed his course and seminar work and passed reading examinations in two foreign languages (usually French and German). The student *should* take the qualifying examination before the beginning of his fifth semester and *must* take it by the end of that semester. In addition to the foreign language examinations and the qualifying examination, the Ph.D. candidate must present a dissertation embodying the results of original research and defend it at a public oral examination. This dissertation must be completed within *three calendar years* after his admission to candidacy, unless an extension is granted by the departmental graduate committee. Each student writing a dissertation will enroll in History 601a, 602b.

COURSES

History 101a, 102b. The Historical Origins of the Contemporary World (3-0-3, each sem.).

A study of the three major revolutions—Scientific, Democratic, and Industrial—

which have most conspicuously shaped the contemporary world. The perspective will be world-historical, with continuing attention to the master problem of the progressive Europeanization of the non-European world. *Mr. Garside*

History 201a. Ancient History (3-0-3).

This course, together with History 202b, 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 202b. Medieval History (3-0-3).

This course is designed to be a continuation of History 201a. Its work is largely devoted to a study of the late Roman Empire and the Middle Ages. *Mrs. Drew*

History 211a. American Thought and Society (3-0-3).

A topical survey of American intellectual and social history in the 17th and 18th centuries. The course is primarily concerned with articulate men, their ideas, and the social circumstances which gave substance to their thought. Main topics include Puritanism, the Puritan in the Enlightenment, and intellectual aspects of the revolutionary period. *Mr. Haskell*

History 212b. American Thought and Society (3-0-3).

A continuation of History 211a covering the 19th and 20th centuries. The course will center thematically on the urban-industrial transformation, and its impact upon ideas and values, from the Jacksonian Era to the New Deal. *Mr. Haskell*

History 221a, 222b. History of China (3-0-3, each sem.).

An introduction to the history and culture of China since the 8th century B.C., examining essential aspects of traditional China to place the modern Chinese experience in perspective. About two thirds of the course will be devoted to the periods from the 17th century to the present. *Mr. Kapp*

History 223a, 224b. History of Science (3-0-3, each sem.).

A broad survey of the development of scientific ideas and methods from the ancient Greeks to the present, with attention to the growth of technology and its relationship to science and society. No special competence in science is required. Open to Freshmen. *Mr. Van Helden*

History 300b. Honors Seminar (3-0-3).

This seminar for students in the honors program will be devoted to the study of "History and the Social Sciences," to the exploration of the relevance of other disciplines for the study of history. The aim is to widen the perspective of history students as to both methods and the kinds of questions that can be asked about the past. *Mr. Wiener*

History 303a, 304b. 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. *Mr. Wiener, Staff*

History 312b. Readings in the History of the Black American (3-0-3).

This is a discussion course including both written and oral reports upon selected reading. Not open to freshmen. *Mr. Higginbotham*

History 332b. The Two Reformations, 1517-1598 (3-0-3).

An analysis of the Protestant and Catholic Reformations of the sixteenth century. Open to Juniors and Seniors with the consent of the instructor. *Mr. Garside*

History 337a. Europe Between Two World Wars (3-0-3).

The peace conference of Paris and its aftermath. The rise, nature, and practices of European fascism and communism. The political, social, and economic problems of the various countries of Europe from 1919 to 1939. The diplomatic background of World War II. *Mr. Rath*

History 352b. 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, 356b. 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, the peace movement, and World War I and American intervention. The second semester covers the diplomacy of the 1920's, American isolationism in the 1930's, World War II, the China tangle, and the growth of rival Western and Communist blocs. *Mr. Patterson*

History 365a. Problems in the History of Nineteenth Century Britain (3-0-3).

A discussion course dealing in depth with selected topics in Victorian history. For Fall 1971, the chief topic will be Victorian morality—its origins, social function and decline. *Mr. Wiener*

History 366b. Problems in the History of Twentieth Century Britain (3-0-3).

A seminar course dealing in depth with selected topics in recent British history. For Spring 1972, the chief topic will be the problem of "modernization" of the British economy, society, and culture. *Mr. Wiener*

History 385a. Readings in the History of Science (3-0-3).

A discussion course with written and oral reports, dealing with the major problems in the history of science and their treatment by historians of science. Open to upperclass and graduate students only. No special competence in science necessary. *Mr. Van Helden*

History 386b. The Scientific Revolution (3-0-3).

Lectures and discussions on the developments in science between 1500 and 1800. Lectures will establish a framework within which students will do more detailed research for oral reports and a term paper. Open to upperclass and graduate students only. No special competence in science necessary. *Mr. Van Helden*

History 395a, 396b. 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. *Mr. Vandiver*

History 397a. The Constitutional History of the United States to 1865 (3-0-3).

This course examines critically major questions in the historical development of American governing institutions, from colonial origins through the Civil War. Lectures, discussions, examinations, and a term paper will attempt to involve students in various approaches to this subject. Background in law is not a prerequisite; college-level competency in modern European, British, and/or United States history is very desirable. *Mr. Hyman*

History 398b. The Constitutional History of the United States since the Civil War (3-0-3).

A continuation of History 397a. This semester examines critically major questions in the historical development of American governing institutions, from Appomattox to the present. *Mr. Hyman*

History 403a, 404b. Senior Essay (3-0-3, each sem.).

A limited number of Seniors majoring in the department are allowed to write an essay in depth on a subject to be approved in advance by their departmental advisers. Open to students in the Honors Program and to other well-qualified students with special permission. Students must take both History 403a 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 416b. Economic History of the United States (3-0-3).

Economic History of the United States from the Colonial Period to the end of the Second World War. Attention will focus upon the trends in per capita income and the forces behind these trends. Individual industries and firms will be studied insofar as they had appreciable influence upon growth trends in the economy. (Also offered as Economics 416b.) *Mr. Seagrave*

History 424b. Problems in Modern Chinese History (3-0-3).

Investigation of selected institutional and intellectual problems of China in the Ch'ing (1644-1911), Republic (1912-49), and the People's Republic (1949-). Prerequisites: History 221a, 222b. *Mr. Kapp*

History 431a, 432b. 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 the field. Prerequisite: History 201a and 202b or consent of instructor. Also offered as Classics 430a,b. *Mr. Lear*

History 440b. Social and Economic History of Europe in the Middle Ages (3-0-3).

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. Open to upperclassmen and graduates with consent of the instructor. *Mrs. Drew*

History 453a. Balkan History (3-0-3).

A survey of the history of Rumania, Yugoslavia, Bulgaria, Albania, Greece, and Turkey and their predecessors from the Byzantine period to the present. Reading knowledge of French or German desirable. (Offered in alternate years with Hist. 345a.) *Mr. Stokes*

History 454b. Balkan History (3-0-3).

A reading and discussion course in which students intensively pursue special topics of interest to them. Individual conferences, reports, discussion and some lectures. Prerequisite: History 453a or consent of instructor. Reading knowledge of French or German desirable. (Offered in alternate years with Hist. 346b.) *Mr. Stokes*

History 455a. Modern Europe, 1871-1914 (3-0-3).

The course is devoted primarily to the rise and decline of classical liberalism, the unification of Germany and its consequences, the emergence of the "new imperialism," the radicalization of European politics and culture after the 1890's, and the coming of the first world war. Special attention is devoted to such outstanding figures as Mazzini, Gladstone, Bismarck, and Burckhardt. Open to all undergraduates. *Mr. Loewenheim*

History 456b. Europe and World Politics 1914 to the Present (3-0-3).

The course is devoted primarily to the first world war and the Russian revolutions, the rise of Mussolini, Stalin, and Hitler, the second world war and its aftermath to Suez and Vietnam. Special attention is devoted to the historic role of the United States in world affairs, from Woodrow Wilson to Lyndon B. Johnson. Open to all undergraduates. *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. *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. *Mr. Gruber*

History 471a. The Enlightenment (3-0-3).

A study of Europe during the Enlightenment with primary focus on France. *Mr. Logan*

History 486b. America's Alternatives (3-0-3).

A close examination of major public policy decisions made from the beginning of the national period to the present, the alternatives to these decisions that were available and known to be available in each instance, and the reasons why choices fell as they did. *Mr. Hyman*

History 493a. Comparative Studies in Russian and Chinese History (3-0-3).

A lecture and discussion course investigating historical questions common to Chinese and Russian experience. Emphasis will be placed on problems of modernization. Prerequisites: Hist. 221a/222b or Hist. 345a/346b. (Offered in alternate years.) *Messrs. Kapp and Stokes*

History 501a, 502b. Historical Research (0-0-3, each sem.).

Master's thesis. Students must take both History 501a and 502b in order to gain credit. *Staff*

History 511a, 512b. Directed Reading in American History I (0-0-3, each sem.).

For graduate students only. *Staff*

History 513a, 514b. Directed Readings in American History II (0-0-3, each sem.).

Staff

History 515a, 516b. Colloquium in American History (0-0-3, each sem.).

An introduction to significant works and trends in American history designed for first year graduate students. *Mr. Gruber and Staff*

History 521a, 522b. Directed Reading in Medieval History (0-0-3, each sem.).

For graduate students only. *Staff*

History 527a, 528b. Directed Readings in Non-Western History (0-0-3, each sem.).

For graduate students only. *Staff*

History 529a, 530b. Directed Readings in Modern European History I (0-0-3, each sem.).

For graduate students only. *Staff*

History 531a, 532b. Directed Reading in Modern European History II (0-0-3, each sem.).

For graduate students only. *Staff*

History 555a, 556b. Seminar in German History (3-0-3, each sem.).

Frederick the Great, Bismarck, and Hitler. Studies in the history of the German political tradition. Qualified undergraduates may be admitted by special permission. *Mr. Loewenheim*

History 565a, 566b. Seminar in Nineteenth and Twentieth Century European History (3-0-3, each sem.).

Selected topics in nineteenth and twentieth century European history. Qualified undergraduates may be admitted by special permission. *Mr. Rath*

History 577a, 578b. The United States in the Philippines, 1899-1914 (3-0-3, each sem.).

Graduate seminar. Open to properly qualified graduate students after consultation with instructor. *Mr. Vandiver*

History 585a. Seminar in United States Constitutional History (3-0-3).

This research seminar will center attention on significant scholarly problems involving mid-nineteenth century developments in the history of civil liberties, criminal law, civil-military relationships, race relationships, and/or the development of urban police power exercised in such subject arenas as public health and safety legislation. In addition to qualified history graduate students, others may request admission whose specializations are in the humanities or in the social sciences or behavioral sciences. Open to graduate students and those students taking History 303a and 304b with Mr. Hyman. *Mr. Hyman*

History 601a, 602b. Historical Research (0-0-3, each sem.).

Doctoral dissertation. May be repeated for credit. *Staff*

History 701a, 702b. Historical Research.

Doctoral dissertation. For students not in residence. *Staff*

History of Art

(*See* pages 213-214)

Italian

(*See* page 155)

Latin

(*See* page 153)

Linguistics

Professor Tyler
Associate Professor Copeland, *Chairman*
Assistant Professors Davis, Gilmartin, Jones and Urrutibeheity

Requirements for the Undergraduate Major in Linquistics: Students majoring in linguistics are required to take a total of ten semester courses in linguistics, eight of which must be on the 300 level or above. All majors are required to take Linguistics 201a, 202b/or the equivalent. With the approval of the major advisor, related courses offered by other departments may be taken for credit towards fulfillment of the requirements in linguistics.

COURSES

Linguistics 201a. Introduction to General Linguistics (3-0-3).

An introduction to the study of language and linguistics giving consideration to basic synchronic concepts and techniques. *Mr. Copeland*

Linguistics 202b. Introduction to General Linguistics (3-0-3).

An introduction to diachronic linguistics and methods in linguistic prehistory. *Mr. Copeland*

Linguistics 301b. Phonological Analysis (3-0-3).

The techniques and assumptions of phonological analysis; as examination of various phonological theories current in modern linguistics. Prerequisite: Linguistics 201-202 or consent of instructor. *Mr. Davis*

Linguistics 302b. Syntactic Analysis (3-0-3).

The theory and techniques of syntactic analysis. Prerequisite: Linguistics 201-202 or consent of instructor. *Mr. Davis*

Linguistics 303a. Modern Linguistic Theory (3-0-3).

A survey of the development of linguistic theory from de Saussure to the present. Prerequisite: Linguistics 201-202 or consent of instructor. *Mr. Davis*

Linguistics 305b. Historical Linguistics (3-0-3).

Linguistic prehistory; the comparative method, internal reconstruction, dialect geography. Prerequisite: Linguistics 201-202 or consent of instructor. Not offered in 1971-72.

Linguistics 310a. Language and Culture (3-0-3).

Investigates the systematic relations between linguistic form and expression and culture. Also offered as Anthropology 313a. *Mr. Tyler*

Linguistics 403-404b. Introduction to the Sanskrit Language (3-0-3).

Study of the forms and syntax of Classical Sanskrit will be followed by reading in Lanman's *Sanskrit Reader,* together with a consideration of Sanskrit as it bears upon Indo-European Linguistics. Not offered in 1971-72. *Miss Gilmartin*

Linguistics 405a. Applied Linguistics (3-0-3).

A course designed to present the relation of structural linquistics to the teaching of modern languages. Prerequisite: Linguistics 201-202 or consent of instructor. Not offered in 1971-72. *Mr. Urrutibeheity*

Linguistics 406a. Field Methods and Analytic Techniques (3-1-3).

The techniques of observation, analysis and recording of human language. Prerequisite: Linguistics 201-202 or consent of instructor. *Mr. Davis*

Linguistics 409. Special Topics in Linguisitics (3-0-3).

The topics will change from year to year. The course may be repeated for credit and will include topics such as mathematical and computational linguistics, transformational grammar, stratificational theory, tragmemic theory, the history of linguistics, acoustic phonetics. Prerequisite: Linguistics 201-202 or consent of instructor. Not offered in 1971-72.

Linguistics 410b. Cognitive Anthropology (3-0-3).

Focuses on the relations between thought, language, and culture. Special emphasis will be given to systems of folk classification and the logical principles underlying them. Also offered as Anthropology 406b *Mr. Tyler*

Linguistics 412b. Linguistic Anthropology (3-0-3).

Devoted to the application of linguistic theory and method in the analysis of cultural materials. Also offered as Anthropology 508b. *Mr. Tyler*

Mathematics

PROFESSOR BOCHNER, *Chairman;* PROFESSORS BAUMSLAG, CURTIS, JONES, RACHFORD AND ULRICH

ASSOCIATE PROFESSORS GERSTEN, HARVEY, HEMPEL, RESNIKOFF, VEECH AND R. O. WELLS

ASSISTANT PROFESSORS FAIRWEATHER, JACO, JACOBOWITZ, POLKING AND RECTOR

VISITING ASSISTANT PROFESSORS HOOBLER AND G. C. EVANS

INSTRUCTORS SMITH AND ZAME

INSTRUCTOR ADAMS

Visitor

ASSOCIATE PROFESSOR BRUCE CHANDLER, PH.D.

COURANT INSTITUTE OF MATHEMATICAL SCIENCES

Requirements for the undergraduate major. It is possible to major in Mathematics in either the science-engineering or humanities (academic) program. There are three major programs.

1. Regular major. Twelve courses in the Mathematics Department are required, of which at least 8 must be numbered above 302. Regular majors cannot take Mathematics 301a, 302b. Mathematics 101a, 102b; 201a, 202b, or their equivalents, are also required.

2. Double major. The requirements in *1.* are modified in two ways. Mathematics 301a, 302b is allowed if required by or desirable for the student's nonmathematics major department. The student may offer up to two nondepartmental courses toward fulfillment of the double major provided these courses are certified by the Mathematics Department as containing adequate mathematical content.

3. *Honors major.* In order to be certified as an honors student a student must have completed at least three semester-courses of the six semester-courses Mathematics 121a, 122b, 221a, 222b, 371a, 372b with grades of 2 or better. In order to have *Honors in Mathematics* entered on his transcript record, a student must have been certified as an honors student and have completed at least two semesters of 400 or 500 level courses with grades of 2 or better by the end of his Junior Year.

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. Ths 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 consist of two parts: the General Examination and the Advanced Examination.

1. The general examination: This examination consists of three parts, covering Algebra, Analysis, and Topology, respectively. The examination will be given twice a year: in mid September and in mid January. A student will be scheduled to take this examination after his third semester of graduate study, but may elect to take it sooner. A student who fails one or more parts of the general examination may, with the approval of the departmental graduate committee, be allowed to retake the appropriate part(s) at the next scheduled examination time. A student will not generally be allowed to take any part of the general examination more than two times.

The following list provides, by reference to standard books, the material to be covered in the general examination:

(a) Algebra
- i) General: Herstein, *Topics in Algebra*
- ii) Commutative Algebra: Atiyah and Macdonald, *Notes on Commutative Algebra,* Chapters I-IX or Zarisky and Samuel, *Commutative Alegbra,* Vol. I, Chapters III-V.

(b) Analysis
- i) Real Analysis: Royden, *Real Analysis,* Section 1-12.
- ii) Complex Analysis: Ahlfors, *Complex Analysis.*

(c) Topology
- i) General: Dugundji, *Topology,* Chapters 1-9 and 11.

ii) Fundamental Group and Covering Spaces, Massey, *Algebraic Topology,* Chapters 2-5.

iii) Elementary Homology Theory: Spanier, *Algebraic Topology,* Chapter 3-5.5.

2. The Advanced Examination. After completing the General Examination the student should prepare for an Advanced Oral Examination in some special field (e.g., homotopy theory, several complex variables, group theory, etc.). Within four weeks after completion of his general examination, the student should submit the topic for his Advanced Oral Examination to the departmental graduate committee for approval. The time of this examination will be scheduled by the graduate committee, and will normally be within six to nine months after the General Examination. A student who fails the Advanced Examination may, with the approval of the graduate committee, be allowed to retake it (on the same, or possibly a different, topic), but will generally not be allowed to take the Advanced Examination more than two times.

Requirements for the Master's Degree

1. To qualify as a candidate for the Master of Arts degree the prospective candidate must have:
   a. Satisfactorily completed (grade of 2- or better) at least eight courses acceptable to the Department, exclusive of Mathematics 601 and 602.
   Note: for students who transfer to Rice while engaged in a course of graduate study, transfer of course credits will be allowed only when approved by both the Department and the University Graduate Council.
   b. Passed an examination in at least one approved foreign language (French, German, or Russian).
2. The remaining requirements for the Master's Degree may be satisfied in either one of the following two ways:
   a. Completion of all the requirements for qualification as a candidate for the Doctor's degree as given below, or
   b. Presentation and oral defense of an original thesis acceptable to the Department.

Requirements for the Doctor's Degree

1. To qualify as a candidate for the Doctor's Degree the prospective candidate must have:
   a. Satisfactorily completed (grade 2- or better) at least twelve courses numbered 400 or higher, exclusive of Mathematics 601 and 602. These courses must be acceptable to the Department. Transfer of credits from another University will be allowed only when approved by both the Department and the University Graduate Council.

   b. Passed both the General and Advanced qualifying examinations described above.
   c. Passed examinations in two approved foreign languages (French, German, or Russian).
2. The remaining requirements for the Doctor's Degree are:
   a. Satisfactory completion (2- or better) of at least fourteen courses numbered 400 or higher, exclusive of Mathematics 601 and 602. These fourteen courses include twelve under the qualifying requirements.
   b. The writing of an original thesis acceptable to the Department.
   c. The passing of a final oral examination on the thesis.
   d. Any other conditions required by the general rules of the University as described on pages 109-110.

COURSES

Mathematics 101a, 102b. Elementary Analysis (4-04), 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. 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 121a, 122b) is the basic course in mathematics and is required of most majors in the Science-Engineering Division. This course, however, is open to all students.

Mathematics 103a. Introduction to Calculus and Its Applications (3-0-3).

Develops techniques of differential and integral calculus with emphasis on problem solving and applications rather than the rigorous underpinnings. Intended for non-Mathematics-Science students and not allowed for Mathematics majors.

Mathematics 104b. Finite Mathematics (3-0-3).

Topics selected from the elementary propositional calculus, sets and subsets, partitions and counting, probability theory on finite sample spaces, finite Markov chains, the gambler's win. Not open for Mathematics majors.

Mathematics 108b. The Role of Mathematics in Civilization (3-0-3).

Intended for students interested in the nature and impact of research mathematics but who do not need mathematics as a tool in their area of specializaion. Number systems, positional notation, efficiency of computation, inequalities, navigation, cartography, algebrization of geometry, calculus, and differential geometry are interwoven to exhibit the mathematical nature of major practical advances.

Mathematics 121a, 122b. Analysis (4-0-4, each sem.).

An honors course for Freshmen. 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 be familiar with techniques of differentiation, integration, areas, volumes, max-min problems, etc., so that emphasis can be placed on the theoretical aspects.

Mathematics 201a. Advanced Analysis (3-0-3).

Topology of R^n, the differential of a function, partial derivatives, chain rule, max-min problems, quadratic forms, Taylor's series, multiple integrals, curvilinear coordinates, change of variables in integration. The requisite linear algebra will be developed.

Mathematics 202b. Advanced Analysis and Ordinary Differential Equations (4-0-4).

Green's theorem, Stokes' theorem, integration of first order equations by elementary methods, geometry of integral curves, existence and uniqueness theorems for first order differential equations, systems of equations, initial and boundary value problems, properties of solutions of linear equations, separation and oscillation theorems, theory of regular singular points, Sturm-Liouville systems, expansion problems.

Mathematics 204b. Linear Algebra (3-0-3).

Linear transformations and matrices, the solution of linear equations, the eigenvalue problem, and quadratic forms. No prerequisites.

Mathematics 221a, 222b. Honors Analysis (3-0-3, each sem.).

The topics of Mathematics 201a, 202b are to be covered with greater generality and completeness, and with due consideration for theory and theoretical background. Additional selected topics may also be introduced.

Mathematics 301a. Ordinary Differential Equations (3-0-3).

Integration of first order equations by elementary methods, geometry of integral curves, existence and uniqueness theorems for first order differential equations, systems of equations, initial and boundary value problems, properties of solutions of linear equations, separation and oscillation theorems, theory of regular singular points, Sturm-Liouville systems, expansion problems.

Mathematics 302b. Partial Differential Equations (3-0-3).

First order linear equations, characteristic curves, method of Lagrange, Cauchy problem for quasi-linear first order equations, existence and uniqueness theorems, classification of higher order equations, reduction to normal form, harmonic functions, Dirichlet, Neumann and mixed boundary value problem, Cauchy problem, initial and boundary value problems for parabolic and hyperbolic equations.

Mathematics 321a. Real Analysis (3-0-3).

Lebesgue and Daniell theory of measure and integration.

Mathematics 321b. Real Analysis (3-0-3).

Same course as 321a.

Mathematics 322a. Complex Analysis (3-0-3).

Power series, line integrals in the plane, Cauchy-Riemann equations, Cauchy's theorem and its consequences, Schwarz' lemma, maximum principle, singularities, calculus of residues and computation of integrals, harmonic functions, Dirichlet's problem and the Poisson integral, infinite series and products of meromorphic functions. Topics such as the Riemann mapping theorem, Runge's theorem, Bergman kernel function, and elementary elliptic function theory will be covered as time permits.

Mathematics 322b. Complex Analysis (3-0-3).

Same course as 322a.

Mathematics 341a. General Topology (3-0-3).

An introduction to the basic notions of point set topology. Topics include elements of set theory, the well ordering principle, general topological spaces, continuity, compactness, connectedness, elementary separation axioms, metric spaces, product spaces, Tychonoff theorem, function spaces, the compact open topology, plus additional topics as time allows, such as Tietze extension theorem, a metrization theorem, arcs, paracompactness. Prerequisite: Mathematics 202b or 222b or consent of instructor.

Mathematics 342b. Geometrical Topology (3-0-3).

An introduction to algebraic methods in topology and differential topology.

Topics include the fundamental group and covering spaces plus additional topics varying from year to year, such as 2-manifolds, elementary dimension theory, simplicial complexes, cohomology theory of manifolds, the DeRham theorem, elementary bundle theory, elementary differential topology. Prerequisite: Mathematics 341a or consent of instructor.

Mathematics 361a, 362b. 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, characteristics values, canonical forms, multilinear algebra. Basis theorem of abelian groups and modules is established. Prerequisite: Mathematics 202b, or 222b.

Mathematics 365a. Elementary Number Theory (3-0-3).

Properties of numbers depending mainly on the notion of divisibility. Prerequisite: Mathematics 101a, 102b.

Mathematics 366b. Projective Geometry (3-0-3).

Projective invariants: Desargues' theorem; Pappus' theorem; the fundamental theorem of projective geometry. The relationship between analytic and synthetic projective geometry; establishing coordinates in a Desarguesian plane, the algebraic significance of Pappus' theorem; equivalence of Pappus' theorem and the fundamental theorem. Higher dimensional spaces; conics; algebraic curves.

Mathematics 371a, 372b. Honors Algebra (3-0-3, each sem.).

An honors course in algebra including the material of Mathematics 361a, 362b, finite group theory, and Galois theory. Prerequisite: Mathematics 222b.

Mathematics 401a, 402b. 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 423a, 424b. Partial Differential Equations (3-0-3, each sem.).

Cauchy-Kowalewski 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 ot solutions of elliptic and parabolic equations.

Mathematics 425a, 426b. Probability Theory (3-0-3).

While topics may vary from year to year, a typical selection would be classical distributions, laws of large numbers, conditional expectation, renewal theory, independence and dependence, Kolmogrov construction of a stochastic process, martingales, Markov chains. Not offered in 1971-72. Prerequisite: Mathematics 321.

Mathematics 431a. Topics in Complex Analysis (3-0-3).

Content varies from year to year. Prerequisite: Mathematics 322.

Mathematics 432b. Topics in Real Analysis (3-0-3).

Content varies from year to year. Prerequisite: Mathematics 321.

Mathematics 434b. Theory of Special Functions (3-0-3).

Study of functions of mathematical physics from the viewpoint of the theory of representations of semisimple Lie groups. Differential equations, functional equations, and recursion relations for Bessel, hypergeometric, parabolic cylinder functions, etc. Spherical functions. Prerequisites: Mathematics 322, 362, 401a.

Mathematics 437a. Numerical Analysis: Numerical Linear Algebra and Ordinary Differential Equations (3-0-3).

Matrix and vector operations: solution of linear systems. determination of eigensystems; condition and rounding errors. Single and multistep methods for initial value problems, finite difference and Galerkin methods for two-point boundary value problems.

Mathematics 438b. Numerical Analysis: Partial Differential Equations and Approximation Theory (3-0-3).

Finite difference and Galerkin methods for partial differential equations, solution of related linear systems using approximate inverse methods: relaxation, alternating direction and factoring. Existence, uniqueness and closeness of solutions to lineai approximation problems; splines, Hermite interpolation.

Mathematics 441a, 442b. 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, Prerequisites: Mathematics 342b and one of Mathematics 122b, 222b, 362b, 372b.

Mathematics 461a, 462b. Topics in Algebra (3-0-3, each sem.).

Content varies from year to year. Prerequisite: Mathematics 362b or 372b.

Mathematics 521a, 522b. Several Complex Variables (3-0-3, each sem.).

Typical topics from the local theory of analytic varieties are: local parameterization, the Remmert-Stein theorem, the proper mapping theorem, uniformization, Chow's theorem, and the algebraic dependence theorem. Typical topics in the global theory of complex manifolds are: holomorphic convexity and pseudo-convexity, the E. E. Levi problem, existence and approximation results for the operator, and analogous results for coherent analytic sheaves.

Mathematics 523a, 524b. Functional Analysis (3-0-3, each sem.).

Topological linear spaces, theory of distributions, Banach algebras, harmonic analysis.

Mathematics 525a, 526b. Advanced Topics in Analysis (3-0-3, each sem.).

Content varies. Enrollment with permission of instructor.

Mathematics 565a. Algebra Colloquium.

Mathematics 567a, 568b. Algebra Seminar.

Mathematics 571a. Algebraic Geometry (3-0-3).

The language of algebraic geometry, e.g., varieties, morphisms. Normalization, nonsingular varieties. Topics such as the Riemann-Roch theorem for curves, intersection theory, elliptic curves, or Jacobian varieties. Prerequisites: 341a, 461a, 462b.

Mathematics 572b. Algebra.

Mathematical Sciences

Professor Thrall, *Chairman;* Professors S. Davis, de Figueiredo, Jackson, Pfeiffer, Rachford, Trammell, Wang and Young
Associate Professors Bowen, Owen and Thompson
Assistant Professors Huband, Lutes and Tapia
Lecturer W. E. Bosarge
Adjunct Professor Cardus
Adjunct Associate Professors Brown and Frankowski

Undergraduate Program

The undergraduate program allows each individual student considerable flexibility to work out a course of study consistent with his particular interests in mathematics and its applications. Available courses provide background for applications to many fields of engineering, natural sciences, life sciences, behavioral and social sciences, and computer sciences.

Within the framework of flexible University requirements, the program consists of three parts: i) basic courses in mathematics and computer science, ii) introductory courses in appropriate "areas" of mathematical sciences, and iii) electives for which "major" credit is given. The latter are typically advanced courses in fields of applications, additional "area" courses in mathematical sciences, and courses in mathematics or mathematical sciences designed to provide mathematical competence needed in fields of application.

Although the student has considerable freedom to concentrate his efforts in mathematical and technical fields, he is encouraged to explore broadly among the disciplines and available courses, in order to broaden his perspectives and enhance his fullest development as a person.

The department has available more detailed statements on program requirements and possibilities. A student contemplating work in mathematical sciences is encouraged to contact the department Undergraduate Program Adviser, or any other member of the department. These persons will be glad to help the student explore program possibilities suited to his individual needs and interests.

Graduate Program

Admission to graduate study in mathematical sciences is open to qualified students holding Bachelor's or Master's degrees (or their equivalent) in engineering, mathematics, or physical, biological, mathematical or behavioral sciences. The credentials of each applicant will receive individual evaluation by the faculty of the Department. Applicants holding Bachelor's degree only are required to submit quantitative and verbal scores from the Graduate Record Examination as a part of the request for application forms.

The graduate program is designed primarily for students seeking the Ph.D. degree, although the Department also offers graduate work leading to the M.A. degree in Mathematical Sciences. 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.

The granting of a graduate degree presupposes demonstrated ability to do advanced original research. Thus the student is encouraged to initiate his research activities at the earliest possible time in his graduate study. Presently the research interests of the faculty are in the following five major areas: (1) Computer Science and Numerical Analysis, (2) Statistics and Probability, (3) Operations Research and Game Theory, (4) Systems and Control Theory, (5) Mathematical Models in Physical, Biological, or Behavioral Sciences. Further information about these areas may be obtained on request from the Department.

Graduate fellowships, research assistantships, and graduate scholarships are available and are awarded on the basis of merit to qualified students. Current practice of the Department is that most graduate students of good standing do receive some financial aid. As an integral part of their scholastic programs all graduate students, regardless of aids, are expected to attain some proficiency in teaching by engaging in instructional assignments of the Department.

Requirements for the Master's Degree

To qualify for the M.A. degree in Mathematical Sciences, the student must have

1. Completed satisfactorily at least ten semester courses (including thesis) at the graduate level, normally five must be courses in Mathematical Sciences. The Student's specific courses of study should be formulated in consultation with his adviser and approved by the Department.
2. Written an original thesis acceptable to the Department while enrolled in MaSc 600 (thesis).
3. Passed a public oral examination on the thesis. (The procedure for the public oral examination is given by the general rules of the University).

A recent decision of the University allows each Department to consider the passing of the qualifying examination for a Ph.D. student (described below) as the fulfilling of the thesis requirement for the Master's degree.

Requirement for the Ph.D. Degree

To qualify for the Ph.D. degree in Mathematical Sciences, the student must have

1. Completed satisfactorily courses of study approved by the Department. At least two courses outside the Department are required.

2. Passed preliminary and qualifying examinations and reviews.

3. Completed satisfactorily two semester courses or passed a reading examination on French, German, Russian or an approved foreign language.

4. Written an original thesis acceptable to the Department while enrolled in MaSc 600 (thesis).

5. Passed a final public oral examination on the thesis. (The procedure is given by the general rules of the University).

COURSES

Mathematical Sciences 300. Model Building (3-0-3).

Selected examples of mathematical models chosen to illustrate (1) formulation of scientific problems in mathematical terms, (2) the solution of the resulting mathematical problems, and (3) the interpretation and evaluation of the solutions. Emphasis on Physical Science Models.

Mathematical Sciences 301. Model Building (3-0-3).

Same as MaSc 300, except emphasis is on Behavioral Science Models.

Mathematical Sciences 340. Partial Differential Equations for Engineers and Scientists (3-0-3).

The expansion of an arbitrary function in terms of orthogonal sets of functions. The solution of boundary value problems in partial differential equations, using these expansions. Applications include problems in vibrations, heat conduction and diffusion. Prerequisite: Mathematics 301.

Mathematical Sciences 361. Computers and Programming (3-4-4).

Computer structure, machine language, instruction execution, addressing techniques, and digital representation of data. Computer systems organization, logic design microprogramming and interpreters. Symbolic coding and assembly systems, macrodefinition and generation, and program segmentation and linkage. Several computer projects to illustrate basic machine structure and programming techniques. A knowledge of ALGOL is assumed. Prerequisite: Engr. 240. Also listed as EE 322.

Mathematical Sciences 380. Introduction to Probability Theory and Statistical Inference (3-0-3).

An introduction to the concepts, interpretations, elementary techniques, and applications of modern probability theory, including a brief introduction to statistical inference. Groundwork is provided for more advanced study in probability theory and in statistics. The course is designed for students in the behavioral, social, and biological sciences. Prerequisite: Math. 102 or 103.

Mathematical Sciences 381. Introduction to Probability Theory and Statistical Inference (3-0-3).

Same as 380, except that more emphasis is given to the needs of students of engineering and the physical sciences. Prerequisites: Math. 102 or 103.

Mathematical Sciences 400. Advanced Model Building (3-0-3).

Continuation of Mathematical Sciences 300 or 301, with increased emphasis on the mathematical solution phase of the models presented. Prerequisite: Mathematical Sciences 300 or 301.

Mathematical Sciences 410. Linear Algebra (3-0-3).

Matrix and vector operations, solution of linear equations, elementary transformations and Gaussian pivots, echelon and hermite canonical forms, linear processes and linear transformations, determinants, similarity, congruence, conjunction, orthogonal and unitary equivalence, unitary geometry and quadratic functions. New concepts are motivated and illustrated via models from the physical and social sciences as well as by applications in core mathematics.

Mathematical Sciences 411. 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 and 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 420. Mathematical Methods in Physics and Engineering (3-0-3).

Application of linear operator theory to the study of differential and integral equations of engineering and mathematical physics. Topics to be included are Fourier series, separation of variables, eigenvalue problems, Green's function and integral equations. Elements of the Calculus of Variations with application to eigenvalue problems.

Mathematical Sciences 430. Complex Variables (3-0-3).

Discussion of the elementary concepts of complex variable theory and applications to the solution of physical problems. Topics include complex numbers, complex functions, contour integration, complex series, analytic continuation, residue theory, conformal mapping and transform theory. Prerequisite: A course in differential equations.

Mathematical Sciences 450. Numerical Algebra (3-0-3).

Analysis of matrix and vector operations, with emphasis on the computational aspects of linear algebra.

Mathematical Sciences 451. Numerical Analysis of Ordinary and Partial Differential Equations. (3-0-3).

Approximations to solutions of ordinary and partial differential equations.

Mathematical Sciences 460. Introduction to Discrete Structures (3-0-3).

An introduction to several discrete mathematical systems useful in various areas of computer science. Topics considered will include a review of set theory, relations and mappings; algebraic systems such as semigroups, groups, rings and fields; graph theory, Boolean algebra and propositional logic. Also listed as EE 422.

Mathematical Sciences 461. Combinatorial Analysis (3-0-3).

An introduction to the techniques of combinatorial analysis. Emphasis will be placed on enumeration problems using the methods of inclusion and exclusion and generating functions. A major goal will be the development of Polya's theory of counting. Additional topics to be covered are applications to graphical enumeration and computer programming. The course will involve extensive problem solving.

Mathematical Sciences 462. Data Structures and Programming Languages (3-4-4).

Basic concepts of data representation. Linear lists, strings, arrays, and orthogonal lists. Representation of trees and graphs. Storage systems and structures, and storage allocation and collection. Multilinked structures. Symbol tables and searching techniques. Sorting (ordering) techniques. Formal specification of data structures, data structures in programming languages, and generalized data management systems. Formal definition of programming languages including specification of syntax and semantics. Simple statements including precedence, infix, prefix and postfix notation. Global properties of algorithmic languages. Laboratory projects. A knowledge of ALGOL is assumed. Also listed as EE 423. Prerequisite: MaSc 361.

Mathematical Sciences 470. 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 non-existence of extrema. Introduction linear, nonlinear and discrete dynamic programming combinatorial problems. Also listed as Econ. 528. Prerequisite: Math. 202.

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 472. Game Theory (3-0-3).

Matrix games; the minimax theorem, relation to linear programming. Continuous games; multi-stage games. Differential games.

Mathematical Sciences 475. Operations Research, Deterministic Models (3-0-3).

An introduction to deterministic models of operations research, beginning with a review of classical optimization techniques and including linear programming, network models, dynamic programming, branch and bound techniques, heuristic approaches and game theory. Present value concepts and capital investment decisions will also be discussed. Prerequisite: Econ. 201 or approval of instructor. Also offered as Engineering 481, Accounting 571, Econ. 481.

Mathematical Sciences 476. Operations Research, Stochastic Models (3-0-3).

A study of elementary stochastic processes and related decision models of operations research; includes an introduction to statistical decision theory, queueing theory, inventory models, Markov chains, replacement models, quality control, and computer simulation techniques. Also listed as Engr. 482, Accounting 572, and Econ. 482. Prerequisite: Econ. 201 or consent of instructor.

Mathematical Sciences 480. Introduction to Statistical Method (3-0-3).

The fundamental ideas introduced in Mathematical Sciences 380 or 381 are utilized to examine the basis of modern statistical method and decision theory. Sufficient application is made of standard techniques to illustrate both the range and the limitations of statistical method, and to provide the background for more specialized courses in applied statistics. Some of the basic models of analysis of variance are studied.

Mathematical Sciences 481. Introduction to Mathematical Statistics (3-0-3).

Intended for students contemplating advanced study in statistical theory. The theory is developed in close connection with the viewpoint of decision theory and is grounded in the underlying probability model. Prerequisite: Mathematical Sciences 380 or 381.

Mathematical Sciences 483. Concepts of Probability Theory (3-0-3).

A conceptual development of probability theory which borrows appropriate results from real analysis where needed. Provides a basis for sound applications of the model to a variety of physical and behavioral problems. Topics such as measurability, integration theorems, almost-sure relationships, and convergence concepts are utilized to provide insight into concepts such as independence, mathematical expectation, correlation, conditional expectation, limit laws, and some topics in random processes. The treatment points to both application and to advance study. Prerequisite: Mathematical Sciences 380 or 381 or permission of the instructor.

Mathematical Sciences 484. Introduction to Continuous-Parameter Stochastic Processes (3-0-3).

Included are such topics as mean-square calculus, spectral decomposition, linear filtering, Markov processes (Chapman-Kolmogorov and Fokker-Planck equations). Some familiarity with the Fourier integral would be desirable. Prerequisite: Math 301 and MaSc 380 or 381.

Mathematical Sciences 485. Linear Models (3-0-3).

Review of univariate distribution theory and inference. The multivariate normal distribution. Multiple and partial correlation. The Wishart distribution. Prerequisites: Linear algebra and one year of probability and statistics.

Mathematical Sciences 486. Multivariate Analysis-I (3-0-3).

Review of univariate distribution theory and inference. The multivariate normal distribution. Multiple and partial correlation. The Wishart distributon. Prerequisite: Linear algebra and one year of probability and statistics.

Mathematical Sciences 487. Bayesian Foundations of Statistical Inference (3-0-3).

Bayes' Theorem, vague prior knowledge, inferences for multivariate distributions, approximation methods, natural conjugate priors, likelihood principle.

Mathematical Sciences 488. Markov Chains (3-0-3).

Theory and applications of discrete-parameter Markov chains with countable state space. Brief introduction to simpler continuous-parameter processes. Prerequisites: Math 201, 202, and MaSc 380 or 381.

Mathematical Sciences 512. Tensor Analysis (3-0-3).

Review of Linear Algebra. Tensor algebra. Tensor analysis on Euclidean spaces. Applications to particle mechanics, continuum mechanics and electromagnetic theory. Prerequisite: A course in linear algebra.

Mathematical Sciences 513. Advanced Tensor Analysis (3-0-3).

Elements of Differential and Integral Calculus on manifolds. Riemannian Geometry. Calculus of variations. Hamilton-Jacobi theory. Applications to analytical mechanics, relativity and continuum mechanics. Prerequisite: Mathematical Sciences 512 or consent of instructor.

Mathematical Sciences 514. Advanced Tensor Analysis (3-0-3).

Continuation of Mathematical Sciences 513.

Mathematical Sciences 515. Mathematical Theory of Nonlinear Elasticity (3-0-3).

A review of the mathematical background for continuum mechanics; basic principles of continuum mechanics; the representation theory for the constitutive relations for elasticity; theory of homogeneous elastic bodies; theory of inhomogeneous elastic bodies; wave propagations in elastic bodies; second-order elasticity and approximation theories. Prerequisite: Mechanical Engineering 511, 512 or Mathematical Sciences 512.

Mathematical Sciences 516. Mathematical Theory of Nonlinear Elasticity (3-0-3).

Continuation of Mathematical Sciences 515.

Mathematical Sciences 517. Mathematical Theory of Non-Newtonian Fluids (3-0-3).

Constitutive relations for materials with memory effects, simple fluids, viscometric flows, motions with constant stretch history, fluid crystals, second-order fluids and other approximation methods.

Mathematical Sciences 522. Applied Functional Analysis (3-0-3).

Review of the basic concepts and theorems in functional analysis; applications to mechanics, quantum mechanics, and/or optimal control problems.

Mathematical Sciences 541. Partial Differential Equations (3-0-3).

Introduction to the theory of partial differential equations, with particular reference to equations of importance in science and engineering. Selected topics from the theory of first-order partial differential equations, characteristics and classifications, initial value problems for higher order equations, boundary value problems for elliptic equations, Riemann's, Green's, and Neumann's functions, and applications of the theory to gas dynamics, electrodynamics, electromagnetism, geometric optics, and fluid mechanics.

Mathematical Sciences 542. Partial Differential Equations (3-0-3).

Further selected topics as described under MaSc 541. The selection is arranged in such a way that MaSc 541 is not a prerequisite.

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.

Mathematical Sciences 550. Nonlinear Approximation (3-0-3).

Varisolvent functions. Approximation by exponential and related functions, by rational functions, by spline functions, and by projection onto submanifolds. Approximation of sets of functions: Kolmogorv's ε-entropy and related results.

Mathematical Sciences 551. Advanced Numerical Analysis (3-0-3).

Typical topics include the Laplace transform and its applications to problems in differential equations and complex variable theory, special functions of mathematical physics, methods of mathematical physics, calculus of variations, numerical analysis. Also listed as Math 535.

Mathematical Sciences 552. Advanced Numerical Analysis (3-0-3).

Continuation of MaSc 551. Also listed as Math 536.

Mathematical Sciences 561. Switching Theory (3-0-3).

Combinatorial gate networks, synchronous and asynchronous sequential networks, fault detection and location in gate networks, the structure of sequential machines, and linear sequential machines. Also listed as EE 522. Prerequisite: MaSc 460 and elementary knowledge of Boolean algebra.

Mathematical Sciences 563. Automata and Formal Languages (3-0-3).

Introduction to recursive functions, formal systems and Turing machines. Godel numbering and unsolvability results, the halting problem and relative uncomputability. Grammars, Chomsky and Greibach Normal Form, pushdown automata and decidability. Also listed as EE 522. Prerequisite: MaSc 460.

Mathematical Sciences 565. Systems Programming (3-4-4).

Review of batch process system programs, components, operating characteristics, user services and their limitations. Implementation techniques for parallel processing of input-output and interrupt handling. Overall structure of multiprogramming systems on multiprocessor hardware configuration. Details on addressing techniques, core management and file system. Traffic control, interprocess communication, design of system modules and interfacing system updating, documentation and operation. Also listed as EE 522. Prerequisite: MaSc 460.

Mathematical Sciences 567. Non-Numeric Programming (3-4-4).

Survey of statistical and heuristic techniques useful in modeling problems in learning and game playing. Methods of simulating cognitive processes. Application of non-numeric languages as SNOBOL 4 and LISP 1.5 to artificial intelligence. Discussion of tree and graph traversal algorithms. Papers from the current literature. Also listed as EE 524. Prerequisite: MaSc 462 and MaSc 380 or 381.

Mathematical Sciences 570. Optimization Theory (3-0-3).

Brief review of metric spaces, normal linear spaces and Hilbert spaces. Introduction to calculus of variations, optimal control theory and dynamic programming. Discussion of the solution of certain problems by variational methods such as the minimum of a quadratic functional. Prerequisites: MaSc 522 or consent of instructor.

Mathematical Sciences 571. Topics in Linear Programming (3-0-3).

Continuation of MaSc 471; schema and duality; double description of classes of convex, linear sets; algorithms for problems with special structures; illustrations from managerial and technical problems. Prerequisite: MaSc 471 or consent of instructor.

Mathematical Sciences 572. Topics in Theory of Games (3-0-3).

Utility theory; theory of 2-person general-sum games, bargaining and threats. Theory of n-person games, solution concepts and extensions. Other topics may be included at instructor's option.

Mathematical Sciences 573. Nonlinear Programming (3-0-3).

Theory and computational methods for nonlinear programming, including Kuhn-Tucker Theory, duality theory, gradient and other methods for constrained and unconstrained nonlinear optimization. Applications, e.g., in control theory, economics and operations research will be discussed.

Mathematical Sciences 574. Integer Programming (3-0-3).

Applications, theory and computational methods in pure and mixed integer programming. Constrained enumeration and cutting plane methods. Asymtotic integer programming. Special problem structures.

Mathematical Sciences 576. Topics in Mathematical Theory of Optimal Control (3-0-3).

Optimal control theory. The maximum principle and dynamic programming. Differential games with applications to pursuit and evasion problems.

Mathematical Sciences 577. Topics in Mathematical Theory of Optimal Control (3-0-3).

Direct methods in control, with applications to lumped- and distributed-parameter control problems. Emphasis will be placed on Galerkin type methods with a detailed analysis of the resulting numerical analytic methods.

Mathematical Sciences 581. Introduction to Statistical Inference (3-0-3).

A course designed for graduate students with limited mathematical background who need a knowledge of statistics in their respective fields. To be taken as PH 211 at UT School of Public Health to obtain course credit.

Mathematical Sciences 583. Topics in Statistics (3-0-3).

Mathematical Sciences 584. Time Series (3-0-3).

Fourier concepts, multivariate probability distributions, stationary processes, autocovariance, power spectra, smoothing, digital filtering, fast Fourier transform, cross spectra. Prerequisite: consent of instructor.

Mathematical Sciences 585. Nonparametric Statistics (3-0-3).

Historical bases, order statistics, quantile intervals, tolerance limits, confidence bands, goodness of fit tests, empty cell tests, run tests, Smirnov tests, Mann-Whitney tests, rank randomization tests. Prerequisite: MaSc 480 or 481.

Mathematical Sciences 586. Multivariate Analysis (3-0-3).

Continuation of MaSc 486. Hotelling's T^2. Fisher's linear discriminant function.

Principal component analysis. Canonical correlation. Multivariate analysis of variance. Multivariate non-normal distributions.

Mathematical Sciences 589. Survival Studies (3-0-3).

Life tables, survivorship distributions, hazard functions, Bayesian and other tests of the difference between two or more survival distributions. Taught at UT Graduate School of Biomedical Sciences.

Mathematical Sciences 590. Seminar in Operations Research. (HACOR)

Mathematical Sciences 591. Seminar in Operations Research. (HACOR)

Mathematical Sciences 592. Seminar in Applied Mathematics.

Mathematical Sciences 593. Seminar in Applied Mathematics.

Mathematical Sciences 596. Special Topics in Mathematical Sciences (3-0-3).

Mathematical Sciences 597. Special Topics in Mathematical Sciences (3-0-3).

Mathematical Sciences 600. Thesis

Mathematical Sciences 601. Thesis

Mathematical Sciences 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. Also offered as Mechanical Engineering 617a. Prerequisites: Mechanical Engineering 511 and 512.

Mathematical Sciences 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. Also offered as Mechanical Engineering 617b. Prerequisites: Mechanical Engineering 617.

Mathematical Sciences 641. Topics in Experimental Design (3-0-3).

Discussion and interpretation of current literature and research relevant to the environmental sciences will be conducted in a seminar setting. Available only to graduate students. Also listed as Envi. 641.

Mathematical Sciences 654. The Minimization of Functions (3-0-3).

Ordinary theory of maxima and minima. Analytical methods. Numerical methods. Gradient methods. Conjugate-gradient methods. Variable-metric methods. Quasi-linearization methods.

Mathematical Sciences 655. Minimization of Functionals (3-0-3).

Optimal control theory and calculus of variations in one independent variable. Analytical methods. Numerical methods. Gradient methods. Quasilinearization methods.

Mathematical Sciences 800. Non-resident Research.

Mechanical Engineering

(*See* pages 198-204)

Military Science

PROFESSOR BISHOP, *Chairman*
VISITING ASSISTANT PROFESSORS SHELTON, NORMAN, SPARKS AND STEIGER

Military Science 101a. U. S. Defense Establishment (1-1-1).

Organization of the Department of Defense to show its relationship to other branches of the federal government. Integration of small units of the army into teams and the general design of military organizations to fit missions to be performed. Marksmanship training, to include functioning, care, and maintenance of the caliber .30 rifle; and range firing of the caliber .22 rifle.

Military Science 102b. The Defense Establishment in National Security (1-1-1).

A presentation of national defense policy and world-wide commitments that require support of the armed forces. The missions, capabilities, and interdependence of the U.S. Army, U.S. Navy, and U.S. Air Force. The mission and capabilities of the U.S. Army Reserve and National Guard. The role of the U.S. Army in tactical and strategical warfare.

Military Science 201a. American Military History (3-1-3).

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. Introduction to Tactics and Operations (3-1-3).

Introduction to troop-leading procedures. Application of basic principles of map and aerial-photograph reading to military science. Mission, organization and composition of basic military teams to include rifle squads, platoons and small combined arms teams. Principles of offensive and defensive combat. Importance of the offensive, stressing necessity for effective coordination of firepower, movement, and communications and command control.

Military Science 301a. Leadership and Management I, Fundamentals and Dynamics of the Military Team (3-2-3).

Principles and techniques of leadership, including the basic qualities of a leader, special problems of military leadership, delegation of authority and responsibility, span of control, planning, coordination, and decision making. The psychological, physiological and sociological factors which affect human behavior. Develop an appreciation of the application of the principles of Internal Defense/Development. History and roles of the various branches of the Army. Representative units to which the student may be assigned will be discussed.

Military Science 302b. Leadership and Management I, Fundamentals and Dynamics of the Military Team I (3-2-3).

Fundamentals of educational psychology as they pertain to the five stages of instructional techniques and the importance of each, including a practical application of military instruction. Principles of offensive and defensive combat and their application to the units of the infantry battalion. Familiarization with the means, principles and techniques of communications, to include communications security.

Military Science 401a. Leadership and Management II, Fundamentals and Dynamics of the Military Team II (3-1-3).

The U.S. and its position in the international affairs of the world today, emphasizing analysis of power factors, competing powers, power blocs, alliances, commitments, and their impact on the Armed Forces. An understanding of command and staff evaluation, organization, and functions using the division staff as model. A fundamental knowledge of logistics as it applies to the supply and movement of tactical units. Principles and analysis of the nature of Internal Defense/Development, emphasizing tactical operations and civil affairs aspects. Military intelligence, methods and procedures for obtaining it, its uses in the formulation of decisions, and the requirements for a sound intelligence security program. The fundamentals of the application of force using as a vehicle the combined arms team. Outline of the organization for administration within the company, battalion and brigade, emphasizing the role of the officer in unit administration. Categories of and organization for tactical readiness.

Military Science 402b. Leadership and Management II, Fundamentals and Dynamics of the Military Team II (3-1-3).

Military justice in the Armed Forces, including the procedures by which judicial and non-judicial disciplinary measures are conducted. Areas where military law varies from civilian law are stressed and the requirement for a separate body of law for the military is shown. Obligations, responsibilities, and benefits of commissioned service. Processes for arriving at sound and timely decisions and translating decisions into plans and orders. Review of map and aerial photograph reading.

Music

The Shepherd School of Music
PROFESSOR HALL
ASSISTANT PROFESSOR KRATZENSTEIN
LECTURER STRONG

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. Kratzenstein*

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 nonchord tones. *Mr. Hall*

Music 385a, 386b. Jones College Applied Music, Instrumental and Vocal Studies (3-0-3, each sem.).

Students wishing to continue study in voice and instrumental music may register in these courses, making their arrangements through the Music Office.

Music 401. Medieval and Renaissance Music (3-0-3).

A history of music from Gregorian chant to 1600. Prerequisite: Music 300 or instructor's permission. Junior standing. Offered in 1972-73. *Mr. Kratzenstein*

Music 402. Music of the Baroque Period (3-0-3).

A history of music from 1600-1750. Prerequisite: Music 300 or instructor's permission. Junior standing. Offered in 1971-72. *Mr. Kratzenstein*

Music 403. Music of the Classic Period (3-0-3).

A history of music from 1725 (Mannheim School) to 1800 (including Beethoven). Prerequisite: Music 300 or instructor's permission. Junior standing. Offered in 1971-72. *Mr. Kratzenstein*

Music 404. Music of the Romantic Period (3-0-3).

A history of music from 1800-1900. Prerequisite: Music 300 or instructor's permission. Junior standing. Offered in 1972-73. *Mr. Kratzenstein*

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*
VISITING ASSOCIATE PROFESSOR GORMAN
VISITING ASSISTANT PROFESSORS DAVIDSON, HENNY, PATE AND VROOM

Naval Science courses as described will be taken in succession as listed

Naval Science 103a, b. Naval Orientation and Introduction to Naval Ships Systems (3-1-3, each sem.).

The fundamental concepts of sea power, naval traditions and customs, seamanship, and the organization and missions of the Navy are presented during the first few weeks of the first semester. The remainder of the course covers types, structure, and missions of naval ships, including ship compartmentation, propulsion systems, auxiliary power systems, interior communications, and control systems. Ship design and stability characteristics are examined.

Naval Science 201a, 202b. Sea Power and Maritime Affairs (1-1-1, each sem.).

Readings, discussions and research on selected topics related to the history, importance and impact of seapower on modern civilization.

Naval Science 302a, b. Navigation and Naval Operations (3-2-3, each sem.).

A comprehensive study of the theory, principles and procedures of ship navigation, movements and employment. Course includes spherical triangulation, sights, sextants and publications and report logs. Tactical formations and dispositions, relative motion, maneuvering board, tactical plots are analyzed for force effectiveness. Ship handling, Rules of the Road, lights, signals and navigational aids.

Naval Science 401a. Naval Weapons (3-1-3).

A descriptive course of naval weapons which includes the concept of weapons systems and the systems approach. The techniques of linear analysis of ballistics and weapons are introduced. The dynamics of the basic components of weapons control systems are investigated and stated as transfer functions. This course provides the tools for the further development in the student understanding of the basic principles that underlie all modern naval weapons systems.

Naval Science 403b. Principles of Naval Organization and Management (3-1-3).

An introduction to the structure and principles of naval organization and management. Naval organization and management practices and the concepts that lie behind them are examined within the context of American social and industrial organization and practice. It includes functions and services of major components of the Navy and Marine Corps, and shipboard organization. Emphasis is placed on management and leadership functions.

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 304Ma. Evolution of Warfare (3-2-3).

Explanation of the forms of warfare practiced by the great peoples of history. Evolutions of strategy, tactics, weapons and material to present.

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 403Mb. Amphibious Warfare (3-2-3).

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.

In addition to the courses listed above, all NROTC students are required to complete civilian faculty taught courses in the following subjects:

American History	3 semester hours
National Security Policy	3 semester hours
Mathematics	6 semester hours
Science	6 semester hours
Computer Science	3 semester hours

Courses in mathematics, science, and computer science must be completed by the end of junior year. Approval of specific courses to meet these requirements will be made by the Professor of Naval Science on an individual basis.

Philosophy

PROFESSOR KOLENDA, *Chairman;* PROFESSORS FULTON AND TSANOFF
ASSOCIATE PROFESSOR GIONNONI
ASSISTANT PROFESSORS AUSTIN AND BURCH
VISITING ASSISTANT PROFESSOR ANGENE

Undergraduate Majors: Undergraduates majoring in philosophy are expected to take ten semester courses in philosophy. Three of these courses may be on the introductory level. At least two should be in the history of philosophy, normally Philosophy 200a,b. In addition, it is recommended that a student choose at least one semester course in each of the following areas: logic, epistemology, and ethics.

Although philosophy is an extremely broad subject, a student majoring in it may pursue his studies in certain specific directions. Philosophy easily merges into a great many related fields, but it is possible to map out some areas of concentration. Three such areas are indicated by the distribution categories of the Rice curriculum. The six categories are listed in pairs, and each pair corresponds to an area in which a philosophy major may decide to concentrate his work. The three areas could be labeled: (A) Humanities, (B) History and Social Sciences, and (C) Mathematics and Physical Sciences.

(A) Literature, art, and religion would be appropriate supplementary fields for a humanistically-oriented philosophy major. Naturally, he should take advantage of philosophy courses which explore these domains. Several such courses are offered by the Department. It may also be desirable for such a student to explore one of the supplementary areas in depth.

(B) A student interested in moral and political questions would be well advised to supplement his courses in ethics and in political philosophy with courses offered by the Social Science departments. To a student with a special interest in the history of philosophy, courses offered by the History Department may be of great relevance. A prelaw student could very well combine philosophical exploration with the study of social institutions, as a suitable preparation for his future career.

(C) Philosophical investigation may also move in the direction of natural sciences and mathematics. A student with this interest will be advised to study at least one of the natural sciences in some depth and to get some mathematical training over and above the courses in logic offered by the Department. A combination of philosophical and scientific training may be an excellent preparation for a premedical student.

A freshman who enters the University with a tentative inclination to major in philosophy is not advised to begin with a heavy schedule in that subject. An introductory course or a course in the history of philosophy may be a good beginning. The rest of his courses should be distributed over a relatively wide area, allowing him to explore fields with which he had no contact in high school. Such gradual introduction into his preferred field with the aid of other educationally important studies during the first two years of college, will enable the student to judge better his real inclinations, interests, and talents.

A student who contemplates the possibility of making philosophy his career should realize that all graduate programs will presuppose his ability to read philosophical material in some foreign languages, as well as Greek and Latin, may be in some cases relevant to the student's philosophical interest. Consequently, he would be well advised to prepare himself during the undergraduate years in one or two of these languages. A student who has had some language instruction in high school would be wise to continue to study that language in order to gain some competence in it. But, the time and the manner in which the student is to pursue his language studies are up to him. Not to have access to philosophical material in a foreign language by the time he is ready to begin his graduate studies, may prove an annoying handicap.

Requirements for the Master of Arts degree include:

(a) The completion with high standing of at least eight advanced semester courses approved by the department.
(b) The passing of a reading examination in one foreign language.
(c) The completion of a written thesis on a subject approved by the department.
(d) The passing of satisfactory written and oral examinations in philosophy, not limited to the student's special field of study.

Requirements for the degree of Doctor of Philosophy include:

(a) The passing of a preliminary examination during the early part of the second semester, based on specific reading chosen from among major philosophical works.
(b) The completion with high standing of courses approved by the department.
(c) The passing of a reading examination in two foreign languages (usually French and German).
(d) The passing of qualifying examinations in history of philosophy, metaphysics, value theory, and logic and epistemology.
(e) 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.

(f) Satisfactory performance of limited teaching duties assigned by the department.

(g) The passing of a final oral examination, not limited to the student's special field of study.

COURSES

Philosophy 120b. Logic (3-0-3).

A study of the principles of valid reasoning, with concentration on the attempt to capture these principles in a formal system. This system will be used to analyze informal reasoning, on the one hand; and the bases of mathematics, on the other. (Note: This course is intended primarily for academic students who do not expect to do further work in logic. It covers much of the same ground as Philosophy 321, and thus is an alternative rather than a preliminary to it.) *Mr. Burch*

Philosophy 200a, b. Leading Minds in Western Civilization (3-0-3).

A course in the history of philosophy in its broad intellectual relations. A study of the most important ideas in Western European and American civilization, examined through the lives and works of leading minds from antiquity to modern times. Open to Freshmen. *Mr. Tsanoff*

Philosophy 221a. Introduction to Philosophy (3-0-3).

Reading and discussion of several classic philosophical works from ancient and modern times, with the view of bringing out the nature of typical philosophical problems and arguments. Open to Freshmen. *Mr. Fulton and Mr. Kolenda*

Philosophy 321a. Logic (3-0-3).

A study of first-order logic with emphasis on natural deduction techniques; also considered are modal logics and a semi-decision procedure for first-order logic. *Mr. Giannoni*

Philosophy 322b. Philosophical Problems in Formal Systems (3-0-3).

A study of the various concepts of consistency, completeness, and decidability, and their applicability to several formal systems, including first-order logic and formal number theory. Also considered are Cantor's paradox, Russell's paradox, and the Lowenheim-Skolem paradox, and the philosophical attempts to resolve them, including the theory of types, intuitionism, and formalism. Goedel's incompleteness proof is discussed with special emphasis on the technique of the proof and its relevance to the philosophy of mathematics. The relationship between deduction in formal systems and ordinary mathematical thinking is considered. *Mr. Giannoni*

Philosophy 323a. Philosophy of Science (3-0-3).

A study of the aims, logical structure, and means of confirmation of scientific theories, with primary reference to historical and contemporary physics. Topics to be considered include: the nature and limitations of scientific explanation, the character of "scientific method," the relation between theory and observation, and the roles of causality and chance in modern physics. *Mr. Austin*

Philosophy 328b. Science, Religion, and Morality (3-0-3).

A study of some possible connections between modern science (especially the social sciences) and contemporary religion and moral philosophy. Materials will be drawn from diverse sources in various scientific disciplines and from recent writings on religion and morality. *Mr. Angene*

Philosophy 331a. Ethics (3-0-3).

A discussion of some traditional and contemporary literature on such topics as skepticism, cultural relativism, egoism, punishment, moral goodness, truth and falsity in moral discourse, and moral psychology. Materials will be drawn from diverse sources. *Mr. Angene*

Philosophy 361a. Philosophy of Art (3-0-3).

An introduction to such problems as the following: What is the nature of art? What is the relationship between art as a whole and specific artistic media? What are the functions of such concepts of criticism as 'style,' 'expression,' 'symbolism.' 'intention,' 'creativity,' 'esthetics,' etc. Illustrations will be drawn mainly from the arts as practiced contemporarily—especially the film arts. *Mr. Angene*

Philosophy 362a. Philosophy in Literature (3-0-3).

Study of philosophical themes in selected works in the English, French, German, and Russian literature 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. Twentieth Century Philosophy (3-0-3).

Reading and discussion of selected writings of some influential philosophers, chiefly American and European. *Mr. Fulton*

Philosophy 425a. 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, behaviorism, and experimentation vs. theory construction; the role of models; the role of statistics. This course is also listed as behavioral science 509. *Mr. Giannoni*

Philosophy 426b. Philosophy of Space and Time (3-0-3).

An examination of the impact of recent scientific theories on our views of the nature and structure of space and time. The following questions, among others, will be discussed: "In what sense do moving rods contract and moving clocks dilate?" "In what way is our space non-Euclidean?" "Why does time have a direction?" *Mr. Burch*

Philosophy 434b. 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. *Mr. Burch*

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. *Mr. Burch*

Philosophy 501a. Research and Thesis (3-0-3).

Staff

Philosophy 502b. Research and Thesis (3-0-3).

Staff

Philosophy 534b. Recent Ethical Theory (3-0-3).

Selected topics in contemporary studies in ethics and theory of action. *Mr. Kolenda*

Philosophy 544b. Metaphysics (3-0-3).

An examination of various issues in metaphysics as dealt with by traditional and contemporary philosophers. The existence of the external world, mind/body, universals, particulars, qualities, substance, etc., are typical topics to be considered.

Aristotle, Aquinas, Hume, Pyle, Strawson, Sartre, are among philosophers to be discussed. *Mr. Angene*

Philosophy 553a. Philosophy of Mind (3-0-3).

A study of contemporary developments in epistemology and philosophical psycology. *Mr. Burch*

Philosophy 561a. Topics in the History of Philosophy I (3-0-3).

Topics will be taken chiefly from ancient philosophy and selected in consultation with each student so as to accord with his needs and interests. The course is intended to promote both general mastery of the subject and the skill in philosophical research and writing. *Mr. Fulton*

Philosophy 562b. Topics in the History of Philosophy II (3-0-3).

Similar to Philosophy 561a, but with topics chosen from the modern period. *Mr. Fulton*

Philosophy 582a. Current Issues in Philosophy of Science (3-0-3).

A survey of basic recent literature concerning the nature of scientific explanation, the structure and function of theories, and the confirmation of theories. *Mr. Austin*

Philosophy 700a. Non-resident Research (credit variable).

Philosophy 700b. Non-resident Research (credit variable).

Physical Education

(*See* pages 234-236)

Physics

Professor Rorschach, *Chairman*
Professors Class, Clayton, Donoho, Duck,
Estle, Michel, Phillips, Risser,
Stebbings, Trammell and Walters
Associate Professors Baker, Lane,
Valkovic and Wolf
Assistant Professors Beam, Guertin, Hannon,
Hungerford and Rundel
Visiting Professor Guth
Lecturer Bryan

Undergraduate Program. The general requirements for the Bachelor of Arts with a major in physics are outlined on pages 62-64. Each student will be assigned a faculty advisor at the end of his Sophomore year, who will be responsible for course registration for the Junior and Senior year. Seven semesters of physics lecture courses and four semesters of physics laboratory courses at or above the 300 level are required. These are

Physics 310a, b and Physics 400a, b
Advanced Laboratory (Physics 330a, b)
Physics 415a, b and Physics 425a
Senior Research (Physics 430a, b)

During the first two years each student should satisfy the physics and mathematics requirements necessary to enroll in 300 level courses. Chemistry 120a, b is also required and should be taken during the first two years. Each student will select courses in Mathematics or Mathematical Sciences in consultation with his advisor so that he will complete three semesters beyond the two-year introductory sequence.

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, and should consult the department chairmen for further details.

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 Astrophysics, Atomic Physics and Quantum Electronics, Biophysics, 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 science and engineering students (see also Physics 110a). Topics of study include: vectors, kinematics, particle dynamics, work and energy, momentum, rotation, oscillations, and the effects of special relativity on Newtonian mechanics. The level of treatment is approximately that of the text "Physics I" by Resnick and Halliday. Students taking Physics 100a should have completed or be concurrently enrolled in Mathematics 101, 102, or equivalent. *Messrs. Duck & Rorschach*

Physics 100b. Beginning Electricity and Magnetism (3-0-3).

The second semester of the sequence in physics for science and engineering students (see also Physics 110b). Topics of study include: the gravitational force and field, electromagnetic forces on charged particles, calculation of electrostatic and magnetostatic fields, induction, and circuits. The level of treatment is approximately that of the text "Physics II" by Halliday and Resnick. Prerequisite: Physics 100a. Students enrolled in this course should also enroll in Physics 130b. *Messrs. Duck & Rorschach*

Physics 101a, b. General Physics (3-0-3).

This course provides a general introduction to physics at a level suited to the needs of students enrolled in the academic and architectural programs. Areas covered include mechanics, thermodynamics, electricity, magnetism, optics, relativity and atomic structure, treated at a mathematical level for which knowledge of the calculus is not required. It is recommended that students enrolled in Physics 101 take concurrently the companion laboratory course Physics 103. *Mr. Class*

Physics 103a, b. Introductory Physics Laboratory (0-3-1, each sem.).

Recommended for all students who wish to receive credit toward gradnation for Physics 101a,b. Experiments on velocities and accelerations of moving bodies, conservation of momentum and energy, and simple harmonic motion. Studies of Boyle's law, Ohm's law, behavior of magnets and transformers and the decay of radioactive elements. *Mr. Class*

Physics 110a. Mechanics (3-0-3).

A course covering the same material at approximately the same level as Physics 100a but in a self-paced format. Students taking Physics 110a should have completed or be concurrently enrolled in Mathematics 101, 102, or equivalent. Limited enrollment. *Messrs. Baker and Cloutier*

Physics 110b. Beginning Electricity and Magnetism (3-0-3).

A course covering the same material at approximately the same level as Physics 100b but in a self-paced format. Prerequisite: Physics 100a, 110a, or equivalent. Students enrolled in this course should also enroll in Physics 130b. Limited enrollment. *Messrs. Baker and Cloutier*

Physics 130b. Elementary Physics Laboratory (0-3-1).

Required of all students who wish to receive credit toward graduation for Physics 100b and Physics 110b. Elementary error analysis. D. C. measurements. Experiments on the classical motion of macroscopic bodies and electrons. Studies of the transient behavior of simple networks containing resistance, capacitance, and inductance. *Mr. Rundel and Staff*

Physics 210a. Intermediate Electricity and Magnetism (3-0-3).

The third semester of the four-semester sequence in physics for science and engineering students. An extension at a more advanced mathematical level of the material begun in Physics 100b, including the fields of moving charges, electrical and magnetic properties of matter and Maxwell's equations. The notation of vector calculus is employed. The level of treatment is approximately that of the text "Electricity and magnetism," by E. M. Purcell. Students enrolled in Physics

210a must have completed Physics 100a,b or equivalent and Mathematics 101, 102 or equivalent. They must be enrolled in a mathematics course of level 200 or higher. Students enrolled in Physics 210a must enroll in Physics 230a.
Messrs. Hungerford and Hannon

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 topics in physical optics including coherence, polarization, interference and diffraction. The level of treatment is approximately that of the text "Waves" by F. S. Crawford. Prerequisite: Physics 210a.
Messrs. Hungerford and Hannon

Physics 230a. Elementary Physics Laboratory (0-3-1).

Required of all students who wish to receive credit toward graduation for Physics 210a. Transient and steady-state behavior of simple linear circuits. Transistor amplifier. Transistor and klystron oscillators. Microwave propagation, polarization, and diffraction. Spectrum of atomic hydrogen. Photoelectric effect.
Mr. Rundel and Staff

Physics 310a, b. Introduction to Quantum 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. Some familiarity with elementary differential equations is assumed. *Mr. Lane*

Physics 330a, b. Junior Physics Laboratory (1-3-2, each sem.).

Required of all Juniors majoring in physics. Introductory experiments in atomic and nuclear physics. Stress is placed on measurements of the fundamental constants of physics. Physics 310a,b must be taken concurrently. *Mr. Donoho*

Physics 400a, b. Introduction to Mathematical Physics (4-0-4, each sem.).

A systematic review of the principal subjects in classical mechanics and electrodynamics. Mathematical methods, including solutions of partial differential equations, vector analysis, matrix algebra, and calculus of variations will be applied to problems on particle and rigid body dynamics, vibrating systems, electro and magnetostatics, electromagnetic waves, and radiation from accelerated charges. Emphasis is placed on solving problems. A recitation session forms an integral part of the course. Prerequisite: Physics 210a,b. *Mr. Valkovic and Staff*

Physics 415a, b. Principles of Modern Physics (3-0-3, each sem.).

This course continues the development of quantum mechanics and modern physics begun in Physics 310. Topics in atomic, molecular, solid state, nuclear and particle physics and relativity are covered. Prerequisite: Physics 310a,b.
Mr. Estle

Physics 425a. Statistical and Thermal Physics (3-0-3, each sem.).

Application to the description of macroscopic systems of the basic concepts and methods of statistical mechanics, thermodynamics, and kinetic theory. Topics include: statistical description of macroscopic systems; statistical basis of thermodynamics; irreversibility and approach to equilibrium; equilibrium conditions; quantum statistics; and elementary kinetic theory of transport processes. The text used is on the level of "Statistical and Thermal Physics," by Reif. *Mr. Hannon*

Physics 426b. Frontiers in Physics (3-0-3).

This course surveys a variety of subjects of current research interest in physics and related fields. Classes consist of either discussions of the subjects using review articles as references or lectures by members of the Rice faculty. The topics are drawn from such fields as relativity, astrophysics, elementary particles, nuclear physics, the physics of condensed-matter, and the philosophical and social aspects of science. Prerequisite: Physics 415a; corequisite: Physics 415b.

Mr. Estle and Staff

Physics 430a, b. Senior Physics Research (0-3-1, each sem.).

Required of all seniors majoring in physics. Students will choose, in consultation with their faculty advisor, a research topic is one of the areas of Astrophysics, Atomic Physics and Quantum Electronics, Nuclear Physics at Low and Intermediate Energies, Solid State and Low Temperature Physics or Theoretical Physics. The work performed will be presented in regular seminars and written research papers.

Mr. Risser

Physics 451. Pioneers of 20th Century Physics (3-0-3).

Begins with a short summary of physics of the 19th century. Evolution of the concepts and principles of modern physics exemplified by historical and critical accounts of the works of the great pioneers, like Planck, Einstein, Rutherford, Bohr, and the founders of Quantum Mechanics, Solid State, and Nuclear Physics, and of Polymer Physics. Construction of a world view of physics as the basis of all science and engineering and an all-important part of our culture and civilization. The human elements of the history of modern physics will be emphasized: the fascinating interplay of personalities, the long story of theories held passionately by their originators in the face of apparent contradiction, ingenious ideas and brilliant guesses leading to new truths—and sometimes, to difficulties and untruths. History of physics as an inspiration to budding research workers: it helps to prepare them for fresh approaches to problems on the frontiers and, in conjunction with philosophy of physics, gives them a vivid impression of the unity, beauty, and economy of physics.

For seniors majoring in science and engineering in general, physics in particular, and for physics graduate students. *Mr. Guth*

Physics 510a. Analytical Dynamics (3-0-3).

Lagrangian and Hamiltonian dynamics, normal vibrations, rigid body motion, the transformation theory of dynamics, and the covariant formulation of special relativity. *Mr. Beam*

Physics 510b. Electromagnetic Theory (3-0-3).

Time-varying electromagnetic fields and boundary-value problems, multipole radiation, radiation from an accelerated charge, radiation reaction, and relativistic electrodynamics. *Mr. Anderson*

Physics 519b.

Introduction to the fundamental concepts and techniques of wave mechanics, including solution of piece-wise constant potential problems, the harmonic oscillator and the hydrogen atom, and discussion of angular momentum and of approximation methods. This course, or its equivalent, is a prerequisite to enrollment in Physics 520. Closed to undergraduates. *Mr. Beam*

Physics 520a, b. Quantum Mechanics (3-0-3, each sem.).

A systematic presentation of quantum principles; brief review of wave mechanics and the motion of wave packets; Hermitean operators, their eigenfunctions of eigenvalues, and the expansion postulates; central-force problems and scattering of a wave packet; partial waves and phase shifts; spin and the rotation group; linear vector spaces; Schrödinger and Heisenberg pictures of quantum dynamics, the equations of motion; symmetry and conservation laws; bound-state perturbation theory; identical particles, time-dependent perturbation theory; emission and absorption by quantized radiation field; introduction to the theory of scattering. Knowledge of the wave mechanics of traditional stationary-state problems, such as is presented in Physics 310 and 415, will be assumed. *Messrs. Lane and Duck*

Physics 525b. Statistical and Thermal Physics (3-0-3).

A continuation of Physics 425a intended primarily for first-year graduate students, and qualified undergraduates. Topics include: kinetic theory of transport processes, irreversible processes and fluctuations, theory of phase transitions, quantum statistics of ideal gases, and principles of quantum statistical mechanics. Prerequisite: Physics 425a or its equivalent. *Staff*

Physics 540a, b. Nuclear Physics (3-0-3, each sem.).

Properties of nuclei in their ground and excited states; the two nucleon system; nuclear forces; the binding energy of nuclei; nuclear models; nuclear reactions and scattering; beta decay; fundamental particles and their interactions. Prerequisite: familiarity with principles and applications of quantum mechanics at level of Physics 310 and 415. *Messrs. Hungerford and Phillips*

Physics 542a. Neutron and Reactor Physics (3-0-3).

Properties and fundamental interactions of neutrons. Interactions of neutrons with nuclei. Neutron sources and detectors. Interaction of neutrons with matter in bulk: moderation, diffusion, spatial distribution in homogeneous media. Criticality and dynamics of homogeneous reactors. Considerations involved in the analysis of high flux and power reactors, systems for auxiliary nuclear power and hazards of nuclear systems. *Mr. Risser*

Physics 542b. Applied Nuclear Physics (3-0-3).

Applications of the principles and techniques of nuclear physics to industry, medicine, and to short- and long-term power needs. Combined lecture and seminar course. *Mr. Risser*

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) caculation 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.

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. *Staff*

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 is assumed. Also offered as Chemistry 563, Electrical Engineering 563, and Materials Science 563. *Mr. Rabson*

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 contibutions 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. Brotzen*

Physics 565. Dielectric & Optional 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 Materials Science 565. *Mr. Estle*

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 Materials Science 566. *Mr. Roberts*

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 Materials Science 567. *Mr. Donoho*

Physics 570. Atomic and Molecular Spectra and Structure (3-0-3).

This course is concerned with the structure and spectra of atoms and molecules. Topics included are fine structure; hyperfine structure; the Zeeman and Stark effects; radiation and selection rules; the Pauli principle and complex spectra. The principal features of the visible, infra-red, ultraviolet and Raman spectra of diatomic molecules will be interpreted. Also treated are the Franck-Condon principle, the classification of electronic states and energy level diagrams. Prerequisite: familiarity with principles and applications of quantum mechanics at level of Physics 310 and 415. *Mr. Stebbings*

Physics 571. Experimental Atomic Physics (3-0-3).

Methods of experimental atomic physics. This course will consider in detail the basic processes of collisions involving ions, atoms, molecules, electrons, and photons. Emphasis will be placed on experimental techniques, and selected experiments will be critically analyzed. Processes to be studied will include elastic scattering, excitation, ionization, charge transfer, and recombination, as measured using such techniques as crossed beams, flowing afterglows, and drift tubes. Prerequisite: Physics 570. *Mr. Rundel*

Physics 572. The Theory of Electronic and Atomic Collisions.

This is a one-semester course with emphasis placed on the quantum mechanical description of electron and atom collisions with atoms, molecules and ions. Standard approximation methods will be critically discussed and results of calculations compared with existing measurements for a variety of systems. Prerequisites are Physics 570 and concurrent enrollment in Physics 520a or permission. The level of treatment will be that of *Topics in Atomic Collision Theory* by S. Geltman. Not offered every year. *Mr. Lane*

Physics 590. Research Work.

Physics 591. Physics Teaching.

Physics 592. Physics Teaching.

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-neutrino fields, nuclear shell theory, few nuclear problems, pion-nuclear physics. Offered in alternate years. *Staff*

Physics 630a. Advanced Quantum Mechanics (3-0-3).

Relativistic wave equations, second quantization of the Klein-Gordon, Dirac and Maxwell field, field theory, S-matrix in the interaction representation, covariant perturbation theory. Feynman diagrams and Feynman rules, quantum electrodynamic processes for spin 0 and spin ½ fields, renormalization theory, anomalous magnetic moment, Lamb shift. *Mr. Guertin*

Physics 630b. Advanced Quantum Mechanics (3-0-3).

Collision theory, formal scattering theory, Lippmann-Schwinger equation, analyticity properties of the S-matrix, causality, optical theorem, dispersion relations, potential scattering, and symmetries and group properties. Selected topics from the theory of weak interactions, strong interactions and current developments in particle physics. *Mr. Guertin*

Physics 640. Special Topics in Nuclear Physics.

Current developments. In 1966-67, a survey of nuclear models. Not offered every year. *Staff*

Physics 660b. Cosmology, 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 660b. *Mr. Clayton*

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*

Physics 800. Nonresident Research.

Political Science

Professor Cooper, *Chairman;* Professors Ambler,
Dix and von der Mehden
Associate Professor Cuthbertson
Assistant Professors Doran, Gerhardt, Hinckley
and Pendley
Lecturer Hudspeth
Visiting Lecturer Jones
Instructor Antunes

Majors in Political Science. Students majoring in Political Science are required to take ten semester courses in the field. All majors must also complete two semester courses of advanced work, selected with the advice of the department, in any of the following fields: anthropology, economics, history, humanities, philosophy, sociology, or psychology. Double majors may apply for permission to substitute two upper-level courses in their second field for two of the ten required Political Science courses.

Within the major each student is encouraged to take a program of courses that provides him with both a broad understanding of the field and a specialized knowledge of some portion of it. Specific distributional requirements are minimal. However, students are required to take at least one course in any *four* of the *six* areas listed below:

1. American Politics
2. Comparative Government
3. Public Law
4. International Relations
5. Normative Political Theory
6. Empirical Theory and Methodology

Political Science 210a, 210b, 211a, and 212b constitute the introductory courses in the four fields of Normative Theory, American Politics, International Relations, and Comparative Government respectively. Majors are encouraged to take one or more of these courses, preferably in their freshman or sophomore years. However, none are *required* of majors, *except that Political Science 210a and 210b remain the courses that meet the Texas state licensing requirements in Political Science.* It should also be noted that *no more than three* of the above introductory courses may be counted toward the major.

Honors Program. Political Science majors who qualify may enter an honors program. The program will consist of (1) a one-semester reading course in the junior year (taken either term) which will serve as the basis for drawing up a prospectus for the senior essay, plus (2) the writing of the essay, normally in the senior year. The three semesters thus consumed will count toward the ten courses required for the major and will be counted for purposes of distribution in the appropriate area within the major. Alternatively, instead of writing the essay, a student may take two graduate-level courses.

Admission to the honors program will, as a rule, be in the spring of the sophomore year, at the time future majors are selected. Others may be admitted during the junior year. Double majors are eligible for the program. Admission requires the approval of the Director of Undergraduate Studies (See Mr. Dix, Cleveland Sewall Hall, Room 486, extension 1215.)

Graduate Program. The Department of Political Science offers a graduate program leading to the Ph.D. The student is expected to take the equivalent of sixteen advanced courses or seminars prior to candidacy and to present a dissertation displaying original research. Normally the student will take the core course and one other seminar or course in American Government, Comparative Government, and International Relations, plus a two semester course in Scope and Methods. The student will also be expected to have some background in traditional political theory prior to entering candidacy. The student is expected to take comprehensive written examinations in American Government, Comparative Government, and International Relations after the completion of 1) course work in the Department, 2) three courses in a minor field (which may be inter-disciplinary) and 3) the language requirement. The language requirement may be fulfilled through a) satisfactory language skill in two foreign languages, b) one language and advanced course in statistics or c) a high level of skill in one language sufficient to use it in advanced research. The language program and minor of the individual student should be decided in consultation with his faculty advisor.

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. 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.

Messrs. Cuthbertson, Gerhardt & Staff

Political Science 211a. International Relations (3-0-3, each sem.)

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 analyzing 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. Doran*

Political Science 212b. Introduction to Comparative Government. (3-0-3).

This course introduces the student to both developed and developing state systems. It will emphasize similarities and differences in concept and practice with regard to institutions, processes, and idealogies. *Mr. von der Mehden*

Political Science 305a. Directed Reading I. (0-0-3).

Independent reading under the supervision of a member of the department. Open to Junior majors in the Honors Program and to others in special cases 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 to Junior majors in the Honors Program and to others in special cases 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. This course should be regarded as a unit covering two semesters. The first semester is a prerequisite for the second. *Mr. Hudspeth*

Political Science 312b. Technology and Society (3-0-3).

The impact of technology on society is discussed through lectures and readings from the viewpoints of behavioral scientists, scientists, and engineers. Typical subjects might include: history of control of the environment, technology and markets, science and public policy, the computer and society, and other topics deemed germane by participants in the course. Also offered as Physical Science 312b. Not offered, 1971-72. *Messrs. Gerhardt, Pendley, and Rudee*

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).

This course examines such problems of national policy and policy-making as linkages between process and output, roles of experts, and uses of program analyses; substantive topics of domestic and national security policy (e. g., aid to education, welfare, support of science, military strategy and weapons systems) are introduced to illustrate the problems. *Mr. Gerhardt*

Political Science 320b. 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. *Messrs. Cuthbertson and Hudspeth*

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. Not offered, 1971-72. *Mr. Cooper*

Political Science 330b. American Parties, Politics, and Pressure Groups (3-0-3).

The nature and functions of contemporary American political parties and pressure 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 335a. Systems Analysis and American Politics (3-0-3).

This course will focus on various systems approaches to politics. Among the topics explored will be general systems theory, Parsonian systems theory, and organization theory. Emphasis will be placed on the utility of these approaches for understanding the operation of parties, legislatures, and bureaucracies in the American political system. *Mr. Cooper*

Political Science 340b. 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 policies; 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. Not offered 1971-72. *Mr. Cuthbertson*

Political Science 350a. Politics of Developing Areas (3-0-3).

A comparative analysis of the political problems confronting developing nations. Emphasis will be placed on problems in the development of new institutions, the role of ideology, and factors in decision making. Not offered 1971-72. *Mr. von der Mehden*

Political Science 352a. The Politics of Southeast Asia (3-0-3).

An analysis of political institutions, processes, and attitudes in selected Southeast Asia states. Emphasis will be placed on the postwar period but traditional forces influencing contemporary political behavior will also be given consideration. *Mr. von der Mehden*

Political Science 352b. Politics of China and Japan (3-0-3).

Political processes, institutions and attitudes of China and Japan; emphasis on post-war developments in relation to traditional patterns, political ideology and international politics. *Mr. von der Mehden*

Political Science 354a. Latin American Politics (3-0-3).

A study of the political process in contemporary Latin America, with particular attention to selected major countries. Emphasis is on the values and social forces that affect politics; the political role of such groups and institutions as the military, the Church, students, labor, and political parties; nationalism; and political violence. An attempt will be made throughout to place Latin American politics within a broader comparative context. *Mr. Dix*

Political Science 358b. The Conditions of Democracy (3-0-3).

A study of the social, economic, psychological, historical, cultural and political roots of stable democracy and of its principal modern antitheses: communism and fascism. Materials relating to Europe, the United States, and the developing nations will be drawn upon. The aim of the course will be to consider the future of democracy as a political system in both the developing and developed nations. Not offered 1971-72. *Mr. Dix*

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 Government: Communist Systems (3-0-3).

A survey of government and politics in selected communist systems, including the U.S.S.R. and Communist China. The course will begin with an analysis of totalitarianism, along with some of its fascist manifestations. Selected communist systems then will be examined and analyzed around three principal themes: their relationship to various concepts of totalitarianism, to Marxist-Leninist theory, and to the Soviet model. Not offered 1971-72. *Mr. Ambler*

Political Science 370b. International Relations Theory (3-0-3).

Primary emphasis during this semester will be given to the exploration of various intellectual devices (field theory, stratification theory, psychological theories) currently used in the analysis of international relations. These will be critiqued in conjunction with the use of current research methodologies (aggregate data analysis, content analysis, crisis analysis, etc.) which will be employed in studies centering around the problems of cooperation and conflict in the international system. Not offered 1971-72. *Mr. Pendley*

Political Science 372b. The Conduct and Control of American Foreign Policy (3-0-3).

This course incorporates both the internal and external determinants of foreign policy leadership. It emphasizes policy formation within the State and Defense Departments, the cost-risk calculus, foreign service professionalism, the impact of elite and interest groups, and the problems of crisis management, nuclear arms, and military intervention in effecting foreign policy. Concepts of sphere of influence, containment, and the "policeman" role will be explored. *Mr. Doran*

Political Science 375b. International Organization (3-0-3).

Consideration of the motivation of nations to organize beyond the nation-state. Regional organization for cooperation (such as the EEC) and for collective security (such as NATO) will be discussed, as well as universal organization for the purposes of collective security (the UN) and solving problems of the maldistribution of human resources (FAO, UNESCO, IBRD, etc.). The seminar will be problem-oriented (e.g., the negotiation of the non-proliferation treaty will be a major concern) and individual research and participation will be emphasized. *Mr. Pendley*

Political Science 385a. Political Socialization (3-0-3).

The study of the ways in which political knowledge, attitudes and values are acquired and modified. Emphasis on political socialization as a particular kind of social learning. Consideration of the impact of political socialization on the political system. In the latter half of the course the class will design and execute a brief research exercise. Not offered 1971-72. *Mr. Antunes*

Political Science 390b. Methods of Political Analysis (3-0-3).

Logic of scientific inquiry. Research design and implementation. Measurement of political variables. Use of the computer in political science. Selected topics in statistical analysis. Exact content will be determined by student interests and research needs. Not offered 1971-72. *Mr. Antunes*

Political Science 405a, b. Senior Thesis (0-0-6).

Open to Senior Honors majors and in special cases to other Honors majors with the permission of the Department. Students must complete both Political Science 405a and 405b in order to obtain credit. *Staff*

Political Science 412a. Seminar in Urban Politics (3-0-3).

The seminar will be concerned with the politics of local justice—people, police, lawyers, courts, prisons. Reading and discussion will focus on the research being done on these topics, and in the second half of the course members of the class will form research groups and disperse to neighborhoods, courts, police stations, libraries, etc. to conduct research of their own design. The major "product" for the class will be the written and oral reports of the various research groups (presented at the end of the semester). *Mr. Antunes*

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 440b. Collective Decision-Making (3-0-3).

An introduction to political decision-making at several levels. Major topics include the individual calculus of interest in the voting act; the formation of constitutions; political exchange models (coalition formation, economic theories of democracy, joint control through organization); and others. Emphasis will be placed on the construction of analytical models which expose the dynamics and problems of collective action. Not offered 1971-72. *Mr. Pendley*

Political Science 450b. Seminar in the Politics of Developing Areas (3-0-3).

Reading and research on selected topics related to the political processes in developing nations. Prerequisite: Consent of the instructor. Not offered 1971-72. *Mr. von der Mehden*

Political Science 452a. Seminar in East Asian Politics (3-0-3).

Reading and research on selected topics related to China, Japan and Southeast Asia in the postwar era. Prerequisite: Consent of the instructor. Not offered 1971-72. *Mr. von der Mehden*

Political Science 454a. Revolutions and Revolutionary Movements (3-0-3).

This seminar will study revolution as a political process. Emphasis will be on the types, causes, and outcomes of revolutions and revolutionary movements, both past and contemporary, and on their relationships to the societies in which they occur. Some consideration will be given to the connection between revolution and political development, and between civil violence and international politics. *Mr. Dix*

Political Science 458a. Political Oppositions (3-0-3).

This seminar will analyze the factors which account for the emergence and institutionalization of democratic political oppositions. The political cleavages that form the bases of such oppositions, and their embodiment in which forms as political parties will also be considered. Reading will include materials relating to Europe, the United States, and the developing nations. Prerequisite: Consent of the instructor. *Mr. Dix*

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. Not offered 1971-72. *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. Not offered 1971-72. *Mr. Ambler*

Political Science 471b. Conflict and Cooperation in the International System (3-0-3).

Study of theories of stability and instability in international relations. Consideration of various levels of analysis (individual, nation-state, systemic) and factors (economics, social change, ideology, aggression, empire-building, etc.) leading to war, integration, alliances and coalitions, etc.; relationships between internal national characteristics and international behavior. *Mr. Pendley*

Political Science 485b. Seminar in Political Behavior (3-0-3).

Black politics. Study of the general problems of assimilation and segregation, ghetto conditions and psychology, black leadership and political behavior and specific problems in the fields of education and employment. Research papers will be undertaken. Prerequisite: Consent of the instructor. *Miss Hinckley*

Political Science 490b. Research Seminar in Modern Political Theory and Interdisciplinary Fields (3-0-3).

The topic for 1971-72 will be Politics and Literature. The seminar considers the development of political friction, the political novel as political theory, and the relevance of the political novel to contemporary problems. Prerequisite: Consent of the instructor. *Mr. Cuthbertson*

Political Science 501a. Statistical Analysis in Political Inquiry (3-0-3).

Explication of the theory and application of statistical inference and univariate and bivariate models, as relevant to political inquiry. Introduction to multivariate statistical models and causal inference. Use of computers in research. Emphasis on application to data from accomplished political research. Required of graduate students without equivalent previous course work. Interested undergraduate students may enroll with permission of the instructor. *Mr. Jones*

Political Science 510a. Scope and Methods (3-0-3).

Introduction to research in political science, problems of the discipline, and basic political concepts. History of political science as a discipline. Scientific method and the logic of social inquiry. Development of political theory. Role of values in political research. Survey of methods and theories used in the various fields in political science. Open to qualified graduate students and to specially qualified undergraduates after consultation with the instructor. *Mr. Antunes*

Political Science 510b. Measurement and Research Design (3-0-3).

Research design. Measurement theory. Data collection and modes of analysis. Use of the computer in political research. Theory building. Selected specific topics, including: aggregate data; survey research; attitude scaling; non-reactive measurement; elite analysis; content analysis; experiment design; system simulation; sampled and real-time observation; longitudinal analysis. Open to graduate students and undergraduates who have completed Political Science 501a or its equivalent *Mr. Antunes*

Political Science 512b. Topics in Statistics (3-0-3).

Selected topics beyond simple associational statistics and regression will be covered with primary emphasis on multivariate methodology, such as factor analysis and small-space analysis. Stress will be placed on applications to political problems, particularly with reference to the research interests of the individual student. Open to graduate students and undergraduates who have completed Political Science 501a or its equivalent. *Mr. Pendley*

Political Science 520a. Approaches to Comparative Government (3-0-3).

Core graduate course analyzing basic approaches to the study of comparative government. Open to qualified graduate students and to specially qualified undergraduates after consultation with the instructor. Not offered 1971-72. *Messrs. Ambler and von der Mehden*

Political Science 530a. Approaches to American Politics (3-0-3).

Core graduate course analyzing basic approaches to the study of American politics. Open to qualified graduate students and to undergraduate students with the consent of the instructor. *Mr. Gerhardt and Miss Hinckley*

Political Science 540a. Approaches to International Relations (3-0-3).

Core graduate course analyzing basic approaches to the study of international relations. Open to qualified graduate students and to specially qualified undergraduates after consultation with the instructor. *Mr. Pendley*

Political Science 570b. Seminar in Comparative Government (3-0-3).

This seminar is devoted to reading and original research on selected topics in comparative government. Open to qualified graduate students and specially qualified undergraduates after consultation with the instructor. Not offered, 1971-72. *Messrs. Ambler and von der Mehden*

Political Science 580b. Seminar in American Politics (3-0-3).

This seminar is devoted to reading and original research on selected topics in American politics. Open to qualified graduate students and undergraduates with the consent of the instructor. *Mr. Cooper*

Political Science 590b. Seminar in the Evolution of the International System (3-0-3).

Examines processes which disrupt, modify, and re-make the international system—imperialism, hegemony, assimilation, order-maintenance. Explores the politico-economic causes, the military-strategic response, and the structural-behavioral aftermath of the five great systemic ruptures (1648, 1713, 1815, 1918, 1945). Analyses mechanisms of systemic change, and examines with aggregate data cyclical patterns of relative war potential variation to test hypotheses about hegemonic probability and assimilative success. *Mr. Doran*

Political Science 598a, b. Directed Reading in Political Science (3-0-3, each sem.).

Staff

Portuguese

(*See* page 155)

Psychology

Professor Howell, *Chairman;* Professors Hudson, Schum and Wann
Associate Professor Brelsford
Assistant Professors du Charme, McGinnis and Nydegger

Undergraduate Major. A total of nine semester courses are required for a major in psychology. The only required courses are Psychology 201a and 302b which, together, encompass the material formerly offered in Psychology 200a (Survey of Psychology) and 306b (Abnormal Psychology). All courses are open to non-majors subject to the approval of the instructors. Those courses having prerequisites are clearly designated below.

COURSES

Psychology 201a. Introduction to Psychology (3-0-3).

What any educated person, non-major and major alike, should know about the field of psychology. The emphasis is upon major concepts, methods and theories, particularly as they relate to everyday life. Two staff members, representing the clinical and experimental areas of the field respectively, share teaching responsibilities. *Mr. Brelsford and Mr. Nydegger*

Psychology 302b. Advanced General Psychology (3-0-3).

A continuation of 201a aimed at deepening the student's understanding of material introduced in that course. Here the emphasis is upon the existing content of the field; the student becomes familiar with several representative research areas (such as social, personality, and learning) and their language. Anyone considering further studies in psychology should take this course. Prerequisite: Psychology 201a or permission of the instructor. *Mr. Brelsford and Mr. Nydegger*

Psychology 303a. Industrial Psychology (3-0-3).

An overview of the principles and techniques of psychology applied in the industrial setting. Coverage includes the traditional topics of personnel selection, placement, and training, together with more recent developments in areas such as motivation, leadership, and organizational behavior patterns. *Mr. Howell*

Psychology 305a. Experimental Social Psychology (3-0-3).

An introduction to some of the theories and experimental approaches involved in the study of social behavior in humans. There will be some exposure to laboratory techniques and research strategies in social psychology. Prerequisites: Psychology 201a and 302b or permission of the instructor. *Mr. Nydegger*

Psychology 307a. Learning (3-0-3).

Introductory survey of issues, theories, and laboratory research in animal and human learning. Topics in animal behavior include motivation, conditioning, generalization, and discrimination. Topics in human learning include attention, problem-solving, storage and retrieval in short- and long-term memory, and forgetting. *Mr. Brelsford and Mr. McGinnis*

Psychology 308b. Mathematical Psychology (3-0-3).

This course examines several areas of psychology in which mathematics has played an important role in providing models for human behavior. Quantitative, experimental approaches to measurement and scaling, decision theory, and learning will be covered. Emphasis will be placed on understanding the models and empirical tests of their predictions. *Mr. McGinnis and Mr. Du Charme*

Psychology 312b. Child Psychology (3-0-3).

This course will cover a variety of theoretical approaches to child development, with special emphasis on characteristic patterns in childhood and adolescence. Some attention will be given problems resulting from faulty development, and the techniques available to deal with these difficulties. Prerequisite: Psychology 201a or permission of the instructor.

Psychology 325a. Basic Statistics—A Programmed Course (3-0-3).

The primary learning experience in this introductory survey of statistics will consist of working through one or more programmed statistics texts. The reading will be self-paced and each of the approximately six examinations may be taken at a time selected by the individual student. *M. McGinnis, Mr. Brelsford, and Mr. Du Charme*

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 325a or MaSc 380a. *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 theories of individual differences in intelligence and personality. *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 351a. The Psychology of Perception (3-0-3).

A critical evaluation of data, theory, and methods in the area of human perception. Demonstrations and in-class experiments will be used as teaching aids. *Mr. Du Charme*

Psychology 352b. The Psychology of Sensation (3-0-3).

Phenomena, methods, and theory in the psychology of sensory systems. Special emphasis on psychophysics and psychophysiology. Students will conduct research projects as part of the course. *Mr. Schum*

Psychology 362b. Physiological Psychology (3-0-3).

An overview of the neurophysiological correlates of overt behavior. Relevant concepts from the physical and biological sciences are reviewed (e.g., neuroanatomy, neurochemistry), following which the topics of neurophysiology, sensory and motor systems, and integrative aspects of brain function are discussed. *Mr. Howell*

Psychology 402b. Development and Growth of New Nations (3-0-3).

Psychological and social forces involved in underdeveloped societies and parallel problems associated with the search for identity among minority groups in the United States. *Mr. Hudson*

Psychology 404b. Human Learning and Memory (3-0-3).

An upper level course dealing with current research and theory in the area of human learning, including memory, and human information processing. Students will conduct an actual research project as part of the course. Content areas will include basic human learning principles, attention mechanisms, short- and long-term memory, retrieval and storage mechanisms, memory difficulties, and memory improvement. Offered alternate years starting in 1971-72. Prerequisite: Psychology 307a or permission of the instructor. *Mr. Brelsford*

Psychology 406b. Recent Developments in Conditioning and Motivation (3-0-3).

The course will be organized around the study of two major concepts: (1) Biofeedback as an explanatory tool in understanding the basic nature of drive, reinforcement, and the conditioning of internal responses such as heart rate and brain waves, and (2) the interactive relationships between selective attention and motivation, discrimination learning, and concept learning. Offered alternate years starting in 1972-73. Prerequisite: Psychology 307a or permission of the instructor. *Mr. McGinnis*

Psychology 410a. Developmental 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. Prerequisite: permission of the instructor. *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. Prerequisite: Psychology 410a. *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. *Mr. Hudson*

Psychology 421a, 422b. Senior Seminar in Psychology (3-0-3).

A seminar on special topics of interest to particular staff members. Intended primarily for psychology majors, but open to others who have sufficient background in the particular area covered. The course will involve reading and discussion of material from journals and other original sources. Announcements concerning specific content and other details will be made each spring for the following year. Prerequisite: permission of the instructor. Can be repeated.

Psychology 431a. Research Perspectives in Psychology (3-0-3).

The student participates in a critical evaluation of current research strategies in psychology. Two instructors, representing different areas and points of view, address the question of what the various approaches have to offer in our search for understanding of mental and behavioral phenomena. Prerequisites: Psychology 201a, 302b, 330, 325a or permission of the instructor. *Mr. Wann and Mr. Schum*

Psychology 434b. Psychopathology (3-0-3).

An advanced course aimed chiefly at critical evaluation of current theories of deviant behavior. The student is introduced to the basic research in the field and some of the more controversial issues. Some attention is also given to the variety of techniques currently available for altering deviant behavior patterns. Prerequisites: Psychology 201a, 302b, 307a, 330, or permission of the instructor. *Mr. Nydegger*

Psychology 452b. Engineering Psychology (3-0-3).

A survey of research on those aspects of human behavior which are relevant to to the design of man-machine systems. The course includes discussion 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.
Mr. Du Charme or Mr. Howell

Psychology 490a, b. Independent Study and Research (3-0-3, each sem.).
Staff

Psychology 599a, b. Research and Thesis in Behavioral Science (variable credit).

Religious Studies

PROFESSOR NIELSEN, *Chairman*
VISITING PROFESSOR NEWPORT
LECTURERS FURSE AND OSHIMA

Undergraduate Majors: All undergraduates majoring in religious studies are expected to enroll in one of the introductory courses offered at the sophomore level. A total of eight semesters of upper-division work will be required for completion of the major. At least two courses are to be elected in each of the following areas represented in the department: 1. Historical and Biblical Studies, 2. Interpretation, theology, comparative religions, 3. Religion in the modern world. Qualified upper-classmen will be given an opportunity to engage in independent work. Related courses offered by other departments may be taken for credit in religious studies with the approval of the major advisor.

Graduate Study: The Department of Religious Studies offers graduate work in a variety of fields. Judeo-Christian Origins, comparative religions, theology, and the philosophy and psychology of religion. In keeping with the traditions of Rice University, study and research are not confessionally oriented. Candidates for the M.A. degree are normally required to take 18 semester hours of courses and write thesis; those for the Ph.D. degree are required to take 36 semester hours of courses and submit a dissertation. The awarding of advanced degrees is not based solely on the accumulation of credits of compliance with formal requirements. Course plans are determined according to the preparation, needs and interests of the candidate. A capacity for independent work is considered essential to study in the department.

Religious Studies 111a, 112b. Religions and Culture (3-0-3).

Introduction to major traditions of religious thought, East and West. Consideration of modern movements such as ecumenism and existentialism. Study of social as well as individual problems of contemporary religious expression and religion in literature.

Religious Studies 202b. Atheism (3-0-3).

Readings in Marx, Feuerbach, Nietzsche, Sartre, Ernest Bloch as well as classical theistic arguments. *Mrs. Furse*

Religious Studies 203a. The Radical Revolutionaries of Thought (3-0-3).

Study of the founders of the great religions as well as contemporary thinkers. *Mr. Oshima*

Religious Studies 221a. First Year Hebrew (3-0-3).

Staff

Religious Studies 222b. First Year Hebrew (3-0-3).

Staff

Religious Studies 301a. Mysticism and Existentialism (3-0-3).

Examination of these two approaches to life in the Christian and non-Christian literature, ancient and modern. *Mrs. Furse*

Religious Studies 302b. Life and Teachings of Jesus (3-0-3).

Historical study of the Gospel narratives; reconstruction of Jesus' ideas and career. Critical evaluation in relation to subsequent theological developments.

Staff

Religious Studies 303a. Job and the Hebrew Prophets (3-0-3).

Historical study of representative Wisdom Literature; Life and teachings of the major and minor prophets.

Religious Studies 311a. History of Religion: The Far Eastern Tradition (3-0-3).

Readings 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*

Religious Studies 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: Religious Studies 311a or permission of instructor. *Mr. Nielsen*

Religious Studies 331a. Psychology of Religion (3-0-3).

Study of some representative traditional and contemporary theories, and an examination of their bearing on practical issues. *Staff*

Religious Studies 362b. Myth, Evil and Immortality (3-0-3).

Special attention to the thought of Mircea Eliade and Paul Ricoeur.

Mr. Oshima

Religious Studies 401a. Independent Study (3-0-3).

Staff

Religious Studies 402b. Independent Study (3-0-3).

Staff

Religious Studies 411a. Ethics of the Life Cycle (3-0-3).

The cycle of birth, adolescence, marriage and death; problems of sex and family ethics, birth control, suicide and euthanasia.

Religious Studies 414b. Creation, Evolution and Ecology (3-0-3).

Readings in the doctrine of nature in de Chardin, Bergson and Whitehead.

Religious Studies 451a. Departmental Seminar for Majors (3-0-3).

Mr. Oshima

Religious Studies 452b. Departmental Seminar for Majors (3-0-3).

Mr. Oshima

Religious Studies 501a. Research and Thesis (3-0-3).

Staff

Religious Studies 502b. Research and Thesis (3-0-3).

Staff

Religious Studies 503a. Old Testament Interpretation (3-0-3).

An interpretation of individual books of the Old Testament based on a careful reading of the English version.

Religious Studies 504b. New Testament Interpretation (3-0-3).

An interpretation of individual books of the New Testament based on a careful reading of the English version.

Religious Studies 505a. New Testament Exegetical Seminar (3-0-3).

An interpretation of selected passages based on careful analysis of the Greek text. Open to graduate students and qualified undergraduate students.

Religious Studies 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*

Religious Studies 523a. Independent Study (3-0-3).

Staff

Religious Studies 524b. Independent Study (3-0-3).

Staff

Religious Studies 525a. Seminar in the Problem of Religious Knowledge (3-0-3).

Mr. Newport

Religious Studies 528b. Ecumenical Theology Seminar (3-0-3).

Mr. Nielsen

Religious Studies 534b. Seminar in Psychology of Religion (3-0-3).

Staff

Religious Studies 541a. Seminar in Ethics (3-0-3).

Religious Studies 551b. Seminar in History of Religion (3-0-3).

Mr. Nielsen

Religious Studies 700a. Non-Resident Research.

Staff

Religious Studies 700b. Non-Resident Research.

Staff

Russian

(*See* pages 155-157)

SCIENCE AND TECHNOLOGY

Physical Science 201a, 202b. Principles and Concepts in the Physical Sciences (3-0-3, each sem.).

A course in the physical sciences designed to acquaint non-science majors with the scientific principles underlying current issues of technological interest. Basic concepts of astronomy, chemistry, engineering, geology, materials sciences and physics will be presented in an integrated fashion as they are needed to develop an understanding of such topics as space flight, nuclear war, pollution, electronic communications, the petroleum industry, computer technology and others.
Messrs. Sass and Brotzen

Physical Science 312b. Technology and Society (3-0-3).

The impact of technology on society is discussed through lectures and readings from the viewpoints of behavioral scientists, scientists, and engineers. Typical subjects might include: history of control of the environment, technology and markets, science and public policy, the computer and society, and other topics deemed germane by participants in the course. Also offered as Political Science 312b. Not offered in 1971-72.

Sociology

PROFESSOR CHAD GORDON, *Chairman*
ASSISTANT PROFESSORS DAVIDSON, MARTIN AND SHELDON
VISITING ASSISTANT PROFESSORS LAMBERT AND LEITER
LECTURER GILES

The Undergraduate Major in Sociology. The goals in sociology are to acquaint the student with the nature of group behavior, social relations and the structure of society. Majors are required to pass a minimum of eight semester-courses in sociology, at least six of which must be at the advanced level, i.e., numbered 300 or higher. No single course is required, but majors will normally be expected to meet the following distribution requirements: (1) at least one *introductory* course (200a or 201b); (2) at least one course emphasizing *theoretical* approaches (315, 400, or 435); (3) at least one course in methodology (420, 520, or other courses in statistics, with the approval of a departmental advisor); and (4) at least three courses in the various areas of sociological specialization (Social stratification, American Ethnic Groups, Sociology of Religion, Life-Cycle, etc.).

COURSES

(*See also* courses in Behavioral Science, pages 136-137)

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. Davidson

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

An examination of the causes and treatment of certain American social problems: crime, alcoholism, mental disorder, drug abuse, sexual deviance, poverty, ethnic conflict and violence. 10-15 hours of field work in one of the treatment areas is expected of each student. *Mr. Leiter*

Sociology 300b. 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. *Mr. Davidson*

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. *Mrs. Sheldon*

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. *Mr. Lambert*

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. *Mr. Lambert*

Sociology 315a. Social Thought and Social Theory (3-0-3).

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

Sociology 318b. Bureaucratic Organization (3-0-3).

A survey of research conducted on large bureaucratic and industrial organizations: public agencies, factories, hospitals, military organizations. Special attention will be given to the dynamics of social authority and to the behavior of small groups functioning as units within the larger organization. Not offered in 1971-72. *Mr. Harwood*

Sociology 320a. Criminology (3-0-3).

A study of the causation, manifestation and control of juvenile delinquency and crime. Topics discussed will include leading theories of the origins and development of criminality, major types of criminal activity and the role of police, prisons, and other social structures in the prevention and control of crime. The course will include regular field trips. *Mr. Leiter*

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. Martin*

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

A seminar devoted to an examination of issues in contemporary sociology, including those concerned with physiologism, behaviorism, positivism, and historicism. Not offered in 1971-72. *Staff*

Sociology 340a. The Family (3-0-3).

A study of theoretical and research problems of the family as a group and as an institution, with primary focus on the family in modern society. Analysis of family relationships: husband-wife, parent-child, larger kin groups. Family conflict and its relationship to small group functioning and to other social units including the larger society. *Mrs. Sheldon*

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

The development of sociological thought through the integration of contributions from biology, philosophy, 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. 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. Not offered in 1971-72.

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

This course will be conducted as a seminar concerned with the historical preconditions of industrialization in Western societies, and the unique characteristics that distinguish industrial society from non-industrial societies. *Mr. Lambert*

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. *Mrs. Sheldon*

Sociology 420a. Research Methods (3-0-3).

An introduction to the major methods of social research, with emphasis on field methods of observation and interviewing. Research projects undertaken by students, working singly or in teams, will serve as a focus for the discussion of methods. *Mr. Leiter*

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

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

Sociology 430a. Sociology of Religion (3-0-3).

A theoretical approach to the study of religion, dealing with cultural, personal, and especially social aspects. Types of religious symbols, action, roles, and collectivities, the process of secularization and the interrelation of religion and other spheres of action will be examined. Not offered in 1971-72. *Mr. Martin*

Sociology 431a. Sociology of the Life-Cycle, I (3-0-3).

A seminar devoted to analysis of socialization, interaction patterns, self-conception development, and aspirations during infancy, childhood and adolescence. Special attention will be given to the effects of sex role, family structure, social class and ethnicity. *Mr. Gordon*

Sociology 432b. Sociology of the Life-Cycle, II (3-0-3).

A seminar devoted to consideration of identify transformations, adult socialization, occupational careers, family interaction patterns, and intergenerational relationships during young adulthood, middle age and full maturity. Special attention will be given to the effects of sex role, family structure, social class and ethnicity. *Mr. Gordon*

Sociology 435b. Sociology of Knowledge (3-0-3).

The relationship between social structures and modes of thought. An introduction to 19th and 20th century thinkers who have dealt with the role of social processes in determining belief systems and ways of reasoning. The theories of: Marx, Scheler, Mannheim, Levy-Bruhl, Durkheim, Weber and Freud. *Mr. Leiter*

Sociology 520b. Quantitative Techniques (3-0-3).

An introduction to the statistical methods used in the analysis of sociological data. *Mrs. Sheldon*

Space Science

PROFESSOR STEBBINGS, *Chairman;* PROFESSORS CLAYTON, DESSLER, GORDON, HEYMANN, MICHEL AND WALTERS
ADJUNCT PROFESSOR LOW
ASSOCIATE PROFESSORS ANDERSON, FREEMAN, HAYMES, LANE AND WOLF
ASSISTANT PROFESSORS CLOUTIER, GOLDWIRE, PREDMORE, RUNDEL AND TALBOT
ADJUNCT ASSISTANT PROFESSORS FEW AND REASONER

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 undergraduate 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 and must 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, as outlined above. In addition, he must demonstrate proficiency in a foreign language approved by our department.

Candidates who hold a master's degree could possibly complete requirements for the doctorate in two years, otherwise a minimum of three years' graduate study is normally required. The student must complete at least 60 hours of approved graduate-level studies and 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. Further details of research programs in space science and departmental degree requirements are contained in a pamphlet, "Graduate Study in Physics and Space Science," available from the Space Science Department on request.

COURSES

Space Science 201a. Introduction to Astronomy (3-3-4).

A self-paced (Keller method) introductory course for academic majors that emphasizes broad qualitative understanding. Topics treated include astronomical instruments, techniques, and methods; astronomical features of the sun and the moon; orbital mechanics, including Newton's and Kepler's Laws; solar and lunar eclipses; and basic principles of spectroscopy. Laboratory hours to be arranged.

Not normally open to Science-Engineering majors. S-E majors are encouraged to enroll in Space Science 400. Limited S-E enrollment in Spac 201 is allowed with the permission of the instructor. A more quantitative, mathematical syllabus is required for those S-E's who enroll. *Mr. Dessler*

Space Science 202b. Introduction to Astronomy (3-3-4).

Same as 201a except topics treated include the planets, stellar formation and evolution, galactic structure, and a description of various cosmological theories. *Mr. Dessler*

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. *Mr. Haymes*

Space Science 401a, 402b. Science Teaching.

Credit to be arranged. Supervised teaching experience in the science classroom or laboratory. *Staff*

Space Science 500a, b. Introduction to Plasma Physics (3-0-3, each sem.).

Topics covered in the first semester will include particle orbit theory, drifts in non-uniform and time-varying fields, the eltcrical conductivity of a plasma, and magnetohydrodynamics. Topics covered in the second semester will include wave modes in cold and hot plasmas, amping of waves, and plasma instabilities. Throughout the course, substantial emphasis will be placed on applications to astrophysics and to the ionosphere, magnetosphere, and solar wind. However, the second semester will also include a study of the plasma confinement problem and current efforts at controlled-fusion devices. *Mr. Wolf*

Space Science 501b. Applications of Plasma Physics (3-0-3).

A discussion of various applications of plasma physics with particular attention to the magnetosphere, ionosphere, and interplanetary space. Topics include wave propagation, plasma wave modes, wave-particle interactions, particle-atmosphere collisions, solar wind interactions with the fields and atmospheres of planets, magnetospheric convection, and some fundamentals of measurements of plasma parameters. *Mr. Reasoner*

Space Science 510a. Analytical Dynamics (3-0-3).

Langrangian and Hamiltonian dynamics, normal vibrations, rigid body motion, the transformation theory of dynamics, and the covariant formulation of special relativity. Also offered as Physics 510a. *Mr. Beam*

Space Science 510b. Electromagnetic Theory (3-0-3).

Time-varying electromagnetic fields and boundary-value problems, multipole radiation, radiation from an accelerated charge, radiation reaction, and relativistic electrodynamics. Also offered as Physics 510b. *Mr. Anderson*

Space Science 520a, b. Principles of Quantum Mechanics (3-0-3, each sem.).

A systematic presentation of quantum principles; brief review of wave mechanics and the motion of wave packets; Hermitean operators, their eigenfunctions and eigenvalues, and the expansion postulates; central-force problems and scattering of a wave packet; partial waves and phase shifts; spin and the rotation group; linear vector spaces; Schrodinger and Hiesenberg pictures of quantum dynamics, the equations of motion; symmetry and conservation laws; bound-state perturbation theory; identical particles, time-dependent perturbation theory; emission and absorption by quantized radiation field; introduction to the theory of scattering. Knowledge of the wave mechanics of traditional stationary-state problems, such as is presented in Physics 310 and 415, will be assumed. Also offered as Physics 520a,b. *Messrs. Lane, Duck, and Goldwire*

Space Science 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 Space 520 is the only prerequisite. Also offered as Physics 550 a, b. *Mr. Talbot*

Space Science 580. Graduate Research. Credit to be arranged.

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 magnetospheric dynamics, infrared astronomy, x-ray astronomy, lunar geology, auroral physics, etc. The emphasis may vary from year to year. *Staff*

Space Science 601a, b. Special Topics in Ionospheric Physics (3-0-3, each sem.).

The topics will vary in accordance with the interests of the participants but will cover areas of current research in ionospheric physics. The orientation will be towards areas of ionospheric physics accessible to study by observational techniques. Included in the topics will be: the incoherent scatter technique; controlled modification of the ionosphere; heat sources in the ionosphere; charged particle density, temperatures, and composition of the ionosphere from an observational and theoretical viewpoint; and airglow as a sensor of ionospheric phenomena. *Mr. Gordon*

Space Science 615a. Experimental Methods of Space Science (3-0-3).

A discussion of the modern techniques and methods of experimental space science. Topics include detection of electromagnetic radiation and particles, information handling and transmission and techniques of data reduction and analysis. Prerequisite: SS 400a,b. *Mr. Reasoner*

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. Clayton

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*

Space Science 800. Non-Resident Research.

Staff

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