

work with consideration of the interrelation of the various school services and community agencies. Credit, 3 hours.

522 Personality Development. Interaction of emotional and cognitive factors in personality development at different age levels in personal life and in school situations. Various personality theories examined. Credit, 3 hours.

523 Psychological Tests. Standardized tests in the study of the individual with emphasis on test score interpretation in counseling. Prerequisites or corequisites: CE 512, 522. Credit, 3 hours.

534 Occupations and Careers. The world of work, value climates and job classification systems, educational and training criteria regarding occupational entry and vertical mobility. Prerequisites or corequisites: CE 512 and 522. Credit, 3 hours.

545 Analysis of the Individual. Theory and methods commonly employed in studying the individual. Observational methods, diagnostic interview, study and semi-structured methods for studying personality. Prerequisites or corequisites: CE 512, 522, 523. Credit, 3 hours.

567 Group Procedures. Principles and techniques of group procedures other than counseling as used in the school program. Prerequisites: CE 523, 534, 545. Credit, 3 hours.

577 Counseling. Principles and application of counseling with particular emphasis on the counseling interview. Prerequisites: CE 523, 545. Credit, 3 hours.

612, 613 Child Counseling. Applications of counseling theory in working with children in clinic and elementary school settings. Practicum required and integrated with didactic instruction. Prerequisite or corequisite: CE 680 and approval of instructor. Credit, 3 hours each semester.

622 Group Counseling. Principles and application of group counseling techniques. Prerequisite: CE 577. Credit, 3 hours.

633 Organization and Administration of Student Personnel Programs. Organizational procedures and patterns, and administrative relationships in student personnel programs. Prerequisites: CE 577 and 622. Credit, 2 hours.

634 Organizational Theory and Change. Conceptual models useful to the counselor in understanding how organizational structures emerge, develop and decline. Organizational goals, theories of organization, authority-subordinate roles, communication within and between organizations. Prerequisite: CE 577. Credit, 3 hours.

644 Psychology of Careers. Structural and developmental theories regarding patterns of occupational choice. The role of counseling in the career planning function. Prerequisite: CE 577. Credit, 3 hours.

655 Student Personnel Work in College and University. Historical development and present status in relation to changing concepts and functions in higher education — junior college, college and university. Observation on college campuses. Prerequisite or corequisite: experience or course work in higher education. Credit, 3 hours.

656 The American College Student. Emphases include interaction of the student and the educational environment, nature of student communities, minority groups, student activism, student influence and varied patterns of structure and function of the college. Credit, 3 hours.

666 Comparative Theories of Personality. Comparative analysis of personality theories in relation to school counseling practices. Prerequisite: CE 577. Credit, 3 hours.

667 Patterns of Behavior Disorders. Common personality and/or emotional disturbances in children, adolescents and adults. Etiology and dynamics of primary behavior disorders, neurotic coping styles, personality disorders and various types of psychosomatic illness. Prerequisite: CE 666. Credit, 3 hours.

668 Personality Assessment. Advanced study

and interpretation of semi-structured personality instruments. Theoretical rationale, administration and use of projective drawings and thematic apperception devices. Prerequisite: CE 577. Credit, 3 hours.

677 Advanced Counseling. Applied technique and tape analysis. Procedures and structure of counseling-pacing, communication, empathy and the helping relationship. Prerequisite: CE 577. Credit, 3 hours.

681 Supervised Practice. Assignment in a school or community agency for supervised experiences in personnel work. Prerequisite: approval of instructor. Credit, 2-6 hours.

722 Philosophies and Theories of Counseling. Philosophical and psychological assumptions of various counseling approaches and various vocational development theories. Implications for school and college counseling situations of each major counseling approach. Prerequisite: CE 677. Credit, 3 hours.

Special Courses: See pages 46-47.

Educational Administration and Supervision

Professors:

WOCHNER (ED A-107 A), ASHE, DEEVER, MENKE, H. MOORE, NEWBURN, M. STOUT, WOOTTON

Associate Professors:

BOGART, DEMEKE, HUNNICUTT, LEVAN, METOS

Assistant Professors:

MAYHEW, WALKER

EDUCATIONAL ADMINISTRATION AND SUPERVISION

EA 511 School Law. Constitutional, statutory and case law that relates to all school personnel, pupils, the school district and other governmental units. Contracts, dismissals, tenure, retirement, pupil injuries, liability of

personnel and district, school district boundary changes, bonding. Credit, 3 hours.

522 Public School Administration. History and development of public school administration in the United States; current organizational patterns for public education at local, county, state and national levels; the administrator's responsibilities in all phases of education. Credit, 4 hours.

534 Instructional Leadership. Curricular practices and processes used by instructional leaders who plan, organize and coordinate the professional activities in elementary and secondary schools. Credit, 3 hours.

538 Administration of the Community School. Philosophy, history, organization and operation of the community-centered school. Introduction of the community education concept into a school system and making it operational. Credit, 3 hours.

544 Public School Finance. School budget procedures, accounting, revenues, state and county finance, and problems relating to financing public education. Prerequisite: admission to Educational Administration program. Credit, 3 hours.

548 Public Relations: The Community School. Administrative factors of primary importance in developing community involvement in public schools. Emphasis is given to the theory and skill of school-system and individual communication. Prerequisite: EA 538 or approval of instructor. Credit, 3 hours.

555 School Plant Planning and Maintenance. School building needs, educational planning for facilities, responsibilities of architects, duties of contractors, equipping and furnishing of school buildings. Prerequisite: admission to Educational Administration program. Credit, 3 hours.

566 Human Relationships in Educational Administration. The administrator's professional relationships with teachers, parents, pupils and other educational leaders within the district. Factors in human relationships

including communication skills, morale, authority and perception through the case approach. Credit, 3 hours.

568 Role and Responsibility of Supervising Teacher. Experiences and content for those planning to become supervisors of student teaching in teacher-education programs. Also serves as in-service training for those already working in student teaching. Credit, 3 hours.

571 School Business Management. Purchasing, budgeting, accounting, payroll management, auditing, financial reporting, insurance and administration of nonteaching personnel and services. Prerequisite: EA 544. Credit, 3 hours.

573 School Personnel Administration. Organization for personnel services; development of policy to govern selection, orientation, placement, remuneration, transfers, separations; and development of morale among instructional and noninstructional personnel. Prerequisite: admission to Educational Administration program. Credit, 3 hours.

576 The School Principalship. Problem and laboratory approaches used to provide application of administrative principles and procedures to the administrative activities of elementary and secondary schools. Prerequisite: admission to Educational Administration program. Credit, 3 hours.

611 Societal Factors Affecting Educational Administration. Interrelated nature of educational administration and the behavioral sciences. Credit, 3 hours.

658 Problems and Issues in Administering Community Education. Utilizes a multidisciplinary approach to provide community educators with an understanding and skill in areas such as school law, school plant management, personnel administration, business practice, school legislation, community education history, research and utilization of local resources. Credit, 3 hours.

673 School Personnel Administration: Issues and Problems. Major current issues and

pertinent research in school personnel administration. Conceptual framework for school personnel administration, role relationships of the school personnel administrator, processes and strategies of staff participation in policy making, strategies for allocating human resources in the school system and the legal status of collective action. Prerequisite: EA 573. Credit, 3 hours.

675 Federal, State and County Education Programs. Function and responsibilities of school administrators relating to federal financial aid to schools; function and responsibilities of state departments of education and county or other intermediate districts in educational programs. Prerequisite: admission to Educational Administration program. Credit, 3 hours.

679 Administration of Special Programs in Education. Designed for personnel responsible for administering special educational services; emphasizes responsibilities of superintendents, principals, supervisors, and directors for special education, student personnel, audiovisual, library science and others. Credit, 3 hours.

711 Administrative Leadership. Emphasis on research in leadership; application of research findings to administrative and supervisory functions in educational endeavors. Prerequisite: 30 semester hours in Educational Administration, or approval of instructor. Credit, 4 hours.

722 Administration of Instructional Improvement. Recent research relating to administrative and supervisory responsibilities for the improvement of the educational program. Emphasis on effective processes by administrators, supervisors, consultants and coordinators. Prerequisite: 30 semester hours in Educational Administration, or approval of instructor. Credit, 4 hours.

733 Administrative Management. Recent research relating to school management. Emphasis in areas of school finance, law, buildings, transportation, food services and

supply management. Prerequisite: 30 semester hours in Educational Administration, or approval of instructor. Credit, 4 hours.

HIGHER EDUCATION

HE 522 Introduction to Higher Education. General introduction and orientation to the broad field of higher education. Credit, 3 hours.

533 The Community-Junior College. Introduction and orientation to the junior college as an institution in American higher education. The history, functions and organization of the junior college are presented. The course is accepted toward professional certification by the Arizona State Board of Directors of Junior Colleges. Credit, 3 hours.

611 Curriculum and Instruction in the Community-Junior College. Principles, patterns and procedures underlying the development of the curriculum in the junior college. Factors affecting the organization and improvement of instruction within such institutions. Prerequisite: HE 533 or approval of the instructor. Credit, 3 hours.

622 Curriculum and Instruction in Higher Education. Current issues and trends in curriculum and instruction in the field of higher education. Prerequisite: HE 522 or approval of instructor. Credit, 3 hours.

644 Financing Higher Education. Income and expenditures for higher education and an analysis of trends in the support of the programs, particularly public higher education. Prerequisite: HE 522 or approval of the instructor. Credit, 3 hours.

679 Administration of the Community-Junior College. Organization and administration of the junior college. Examination of organizational relationships, administrative problems encountered and practices employed in the operation of this type of institution. Prerequisite: HE 533 or approval of instructor. Credit, 3 hours.

689 Administration of Higher Education.

Problems involved in the administration of institutions of higher education. Prerequisite: HE 522 or approval of instructor. Credit, 3 hours.

Special Courses: See pages 46-47.

Educational Foundations

Professors:

RALSTON (ED A-400 D), BELOK, HOOVER, MITCHELL

Associate Professors:

ABBOTT, BAUMANN, BROOK, HARDT, KINGSBURY, MOULTON, SHAFER, SKELTON, THOMAS

Assistant Professor:

MORRIS

EDUCATIONAL FOUNDATIONS

EF 111 Exploration of Education. Education as an instrument in the development of the individual and society; its significance as an American institution. Credit, 3 hours.

333 Basic Issues in Education. Basic social and philosophical issues facing educators through use of problem-solving and philosophical analysis. Credit, 3 hours.

411 General Semantics in Education. Demonstrations, research, intensive reading in original documents and applications in general semantics. Credit, 3 hours.

422 Group Dynamics and the Educational Process. Leadership potential by understanding and using group processes in education and human relations. Formation of groups, development of group leadership, communications within groups and relations between group and individual members. The use of problems and expectations of group work as an educational instrument. Credit, 3 hours.

445 Education for Survival. Content, materials, and methods for teachers in creating awareness of the survival of life on earth; overpopulation, technology, energy usage, resource depletion and general environmental degradation. Credit, 3 hours.

500 Educational Research. An introductory course designed for students with a minimal background in statistics, tests, and measurements and related skills. Emphasizes the production and consumption of educational research as basic to all class instruction and foundational to graduate programs. Research study is required. Credit, 3 hours.

622 Contemporary Education. Critical, student-centered research into the dominant movements in contemporary education in America; the semantic-cultural-ideological bases of these movements. Prerequisites: SF 433 or 522, or 544 and approval of instructor. Credit, 3 hours.

SOCIAL AND PHILOSOPHICAL FOUNDATIONS

SF 411 History of American Education. The social life, ideas and institutions that have given direction to education in the United States. A background for understanding and evaluating present educational problems. Credit, 3 hours.

422 Educational Sociology. Education in relation to social institutions. Considers methods of gathering data in social research, the family, problems of educational reconstruction, social relationships and social measurements. Credit, 3 hours.

433 Philosophy of Education. Philosophical foundations of contemporary educational ideas. Introductory considerations for the development of a philosophy of education. Credit, 3 hours.

435 Education and National Goals. Case studies in comparative and international education. Interrelationship of education with political ideologies, economic conditions, social

organization and values existing in certain selected cultures. Credit, 3 hours.

511 School and Society. Interrelationship of school and society and the place of education in social change. Credit, 3 hours.

522 Education and Democratic Values. Education as a moral enterprise in which the school seeks to cultivate school values by the subject matter and methods it employs in its program. Credit, 3 hours.

533 Comparative Education in the Western World. Educational systems, ideas and traditions of the leading nations of Europe including the Soviet Union. Credit, 3 hours.

534 Education and Change. Role of education in producing change in economic and socio-political conditions in the developing nations of Africa, Asia and Latin America. Credit, 3 hours.

544 Philosophic Foundations of Education. Major points of view in contemporary educational thought, emphasizing the basic issues in general philosophy which are foundational to education. Credit, 3 hours.

555 Education Classics. Selected documents from the past for the purpose of finding useful suggestions for dealing with present educational problems. Credit, 3 hours.

566 History of Education. Development of educational institutions and ideas in the Western World, from ancient times to the 20th century. Credit, 3 hours.

635 Education, Politics and Power. Educational systems as agencies of political socialization. Forces which shape educational policy; allocation of resources to education; locus of power and influence groups, decision-making in the schools. Credit, 3 hours.

711 Social and Historical Foundations of Education. Critical examination of the characteristics and problems of modern American education and the social and historical context from which they have emerged. Prerequisite: SF 544. Credit, 4 hours.

722 Recent Developments in Philosophy of Education. Trends in contemporary educational thought. Prerequisite: SF 544. Credit, 4 hours.

Special Courses: See pages 46-47.

Educational Psychology

Professors:

VAN WAGENEN, GAFFNEY
HELMSTADTER, STAFFORD, VAN WAGENEN

Associate Professor:
KERR

Assistant Professors:
FRY, KLINGENSMITH, SATTLER

EP 310 Educational Psychology. The study of human behavior in educational situations. Prerequisite: PX 100 or approval of the instructor. May be repeated for credit up to a total of three hours. Credit, 1-3 hours.

450 Principles of Measurement and Evaluation. Major concepts and basic logic involved in the assessment of human abilities and school accomplishment. Nature of tests, the use of test information in making educational decisions, systems of grading, the process of test standardization and the concepts of test reliability and validity. Credit, 3 hours.

452 Laboratory in Test Construction and Interpretation. Principles of educational measurement and evaluation. Construction of classroom examinations, the assignment of grades and the interpretation of widely-used group measures of school ability and achievement. Credit, 2 hours.

454 Introduction to Statistics. A conceptual approach to statistical procedures used in the description and analysis of educational data. Descriptive statistics, probability and theoretical frequency distributions, introduction to the logic of hypothesis testing, basic parametric and nonparametric procedures. Credit, 3 hours.

510 Essentials of Classroom Learning. Empirical approaches to the development of learning and motivation: acquisition and forgetting, transfer of training, and the control of incentive conditions presented on an experimental basis and related to educational processes. Prerequisite: EP 310 or equivalent. Credit, 3 hours.

512 Special Topics in Educational Psychology. A concentrated survey of the major content areas and experimental approaches in educational psychology. Prerequisite: approval of instructor. Credit, 3 hours.

513 Psychology of the Elementary School Child. Mental, physical, social and emotional development of children during early, middle and late childhood with emphasis on the application of psychological theory to problems of teaching in the elementary school. Prerequisite: EP 310. Credit, 3 hours.

514 Psychology of the Adolescent. Mental, physical, social and emotional development in adolescence and emphasis on the influence of various aspects and activities of the secondary school on adolescent development. Prerequisites: PX 100, EP 310 or equivalents. Credit, 3 hours.

515 Psychology of Teaching Adults. Psycho-educational problems in teaching the adult learner, emphasizing individual differences, remedial procedures and adjustment problems of the adult. Prerequisites: EP 310, 510. Credit, 1-3 hours.

516 Behavioral Approaches to School Instruction. Provides behavioral approaches for working with learning, motivation and social problems that are typically encountered in the school. Prerequisite: approval of instructor. Credit, 3 hours.

530 Theoretical Issues and Contemporary Research in Child Development. Psychological theories, research and methods relevant to child development with particular emphasis on the relations between early development and later performance. Prerequisite: EP 512. Credit, 3 hours.

532 Psychology of Exceptionality. General psychological theory and experimental research relevant to exceptionality with emphasis on implications for educational programs which take cognizance of unique learner characteristics. Prerequisite: EP 512. Credit, 3 hours.

540 Theoretical Views of Learning. Classical and cognitive theories of learning, plus recent orientations. Illustrative experimental and rational foundations; implications for educational practice, whenever feasible. Prerequisites: 12 semester hours in psychology or educational psychology. Credit, 3 hours.

542 Automated Instructional Techniques. Application of psychological principles to the automation of certain instructional processes. Principles of self-instruction programming; development, revision and testing of programmed learning sequences. Prerequisites: PY 112 and EP 510. Credit, 3 hours.

544 Psychology of Reading. Alternative analyses of the reading process; designs and procedures used to investigate instructional and noninstructional variables related to reading achievement. Prerequisites: EP 454, 510 or 512. Credit, 3 hours.

550 Current Issues in Measurement. Current major issues in measurement examined through a review of research literature, with emphasis on the development of theoretical approaches to educational measurement and the implications of these developments for educational measurement and evaluation. Prerequisites: EP 450, 454. Credit, 3 hours.

554 Multivariate Statistical Procedures. Basic multivariate procedures for analyzing educational data, including analysis of variance and covariance, multiple regression and discriminant function. Introduction to sampling techniques and experimental design. Prerequisite: EP 454 or equivalent. Credit, 3 hours.

555 Data Processing Techniques in Measurement and Research. Application of modern data processing methods to problems in

educational measurement and research. Introduction to computer programming, use of computer libraries, familiarity with basic tabulating equipment, coding and analysis of mass data arising in testing programs and educational research. Prerequisites: EP 450 and 454. Credit, 3 hours.

556 Special Quantitative Techniques. Introduction to special techniques for analyzing educational data including factor analysis, psychometric scaling, sociometry, the semantic differential technique, and special non-parametric procedures. Prerequisites: EP 554, 550. Credit, 3 hours.

560 Individual Measurement in School Psychology. Individual test administration and experience in interpreting the results of the test to school personnel. Prerequisites: EP 450, 510 or 512, and approval of instructor. Credit, 3 hours.

562 School Psychology: Theory and Practice. Development and present status of school psychology with an emphasis on role and functions: educational diagnosis, school testing programs, interviewing, report writing, consultation and in-service training. Prerequisites: EP 454, 532 and 560. Credit, 3 hours.

566 Diagnosis of Learning Difficulties. Clinical diagnosis of learning difficulties emphasizing specific academic problems. Use and interpretation of diagnostic instruments in practical school situations. Prerequisites: EP 450, 510 or 512, 560 and 562. Credit, 3 hours.

710 Educational Psychology. Theory and research literature in educational psychology, and their implications for educational practice. Credit, 3 hours.

748 Recent Studies in Educational Psychology. Recent selected literature in educational psychology, involving critical reading and discussion. Prerequisite: 15 semester hours in educational psychology. Credit, 3 hours.

Special Courses: See pages 46-47.

Special Education

Professors:

ABRAHAM (ED B-301), SUNDWALL

Associate Professors:

FAAS, B. MOORE, WARREN

Assistant Professors:

BROWN, GILL, NELSON, NEWMAN,
ROBERTS

INDIAN EDUCATION

IE 411 Indian Education. Foundations and history of Indian education and present day implications. Credit, 3 hours.

422 Methods of Teaching Indian Children. Materials and methods particularly suited to the education of Indian students. Effective use of local and tribal materials in the classroom. Experimentation with new ideas provided. Credit, 3 hours.

424 Curriculum and Practices for Indian Education. Curriculum problems and recommended practices of Indian education. Review of past and present Bureau of Indian Affairs and public school curriculums. Specific techniques examined for curriculum improvement in Indian education. Credit, 3 hours.

425 Educational Applications in Anthropology. Education and its relation to anthropology. Values and implicit cultural assumptions with their impact on education. Use of case study approach in understanding the influence of social and cultural factors in the educative process. Credit, 3 hours.

433 Guidance for the Indian Student. Problems faced in providing adequate guidance services to Indian students and the necessity for cultural understanding in guidance. Consideration given to the effect of tribal values and their relationship to effective guidance. Credit, 3 hours.

490 Problems of Teachers of Indian Children. Current issues, trends and problems encoun-

tered by teachers of Indian children. Oral and written English and reading receive emphasis. Current research reviewed and evaluated. Credit, 3 hours.

511 School-Community Relations in Indian Education. Specific techniques and methods utilized in realizing harmonious and effective relations between the school with Indian children and the community in which these children live. Credit, 3 hours.

522 Education of Indian Adults. Methods used to establish Indian adult education, principles involved in determining course selection and content; successful Indian adult education programs and their essential ingredients. Credit, 3 hours.

544 Community Development in Indian Education. Methods and techniques for initiating community development programs in Indian communities; role and responsibilities of school personnel, community leaders and individuals. Credit, 3 hours.

SPECIAL EDUCATION

SP 311 Orientation to Education of Exceptional Children. Study of exceptional children, including gifted, mentally retarded, sight, hearing, speech, emotional disturbance, disadvantaged, specific learning disabilities and others. Observation of exceptional children in classroom situations. Credit, 3 hours.

312 Mental Retardation. Nature and characteristics of mental retardation in children and adults. Appropriate techniques of instruction, training and therapy. Credit, 3 hours.

320 Participation with Mentally Retarded Children. Clinical and laboratory experience with the mentally retarded in cooperating clinics, institutions, schools and agencies. Prerequisites: SP 312 or approval of instructor; SP 321 to be taken concurrently. Credit, 3 hours.

321 Methods of Teaching the Mentally Retarded. Methods, materials and curricula suitable for the mentally retarded. Procedures

currently useful at elementary and secondary levels. Prerequisites: SP 311, 312. SP 320 to be taken concurrently. Credit, 3 hours.

404 Psychological, Social and Health Aspects of Mental Retardation. Multidisciplinary approach to the problem of mental retardation in children. Contributions provided by well-qualified persons in the fields of pediatrics, psychology, social work and public health nursing. Credit, 1 hour.

436 The Emotionally Disturbed Child. Survey of patterns of maladaptive behavior in children and adolescents. Exploration and evaluation of biological, psychological and sociological causal factors. Credit, 3 hours.

446 The Disadvantaged Child. The deprived child in terms of his physical, social, economic, psychological and educational needs. Material from all the major disciplines used to help understand the child and his problems. Credit, 3 hours.

447 Methods of Teaching the Disadvantaged. Techniques for organizing and providing special educational experiences for students from deprived or culturally different backgrounds. Prerequisite: SP 446. Credit, 3 hours.

448 The Mexican American Child. A multidisciplinary study of the Mexican American child, including psychological, sociological, cultural and bilingual factors. Credit, 3 hours.

461 Characteristics and Diagnosis of Learning Disabilities. Definitions, incidence, causes and diagnosis of specific learning disabilities. Credit, 3 hours.

462 Methods of Remediating Learning Disabilities. Methods and materials for use in the remediation of specific learning disabilities. Prerequisite: SP 461. Credit, 3 hours.

471 Art, Music and Crafts for the Handicapped. Use of art, music and crafts in the motivation and development of the sensory motor skills of the handicapped. Prerequisite: SP 321 or equivalent. Credit, 3 hours.

474 Educational Evaluation of the Handicapped. Educational evaluation techniques for

use by teachers of handicapped children. Teacher understanding and use of results of individual psychological test data. Prerequisites: SP 311 and a methods course with exceptional children or equivalents. \$5.00 fee. Credit, 3 hours.

488 The Gifted Child. Gifted children's needs and characteristics; appropriate materials and methods; teacher qualifications. Techniques and values related to acceleration, enrichment, special classes; research of Terman, Hollingworth, Witty and others. Credit, 3 hours.

511 The Exceptional Child. Educational needs of handicapped and gifted children. (Not available to students who have completed SP 311 or the Summer Workshop in Exceptional Children.) Credit, 3 hours.

512 The Mentally Retarded Child. Mentally retarded children, appropriate materials and methods, teacher qualifications, educability, and special problems. Credit, 3 hours.

514 Methods and Materials with Exceptional Children — I. Methods and materials for the development of the sensory-motor skills for mentally retarded, emotionally disturbed, learning disabled and disadvantaged children, with emphasis on perceptual-motor skills, visual-motor integration and other readiness activities. Prerequisite: SP 511 or equivalent. Credit, 3 hours.

515 Methods and Materials with Exceptional Children — II. Methods and materials for the development of language and academic skills for mentally retarded, emotionally disturbed, learning disabled and disadvantaged children. Prerequisite: SP 514. Credit, 3 hours.

517 Communication with Parents of Exceptional Children. Discussion of objectives in parent-teacher conferences and techniques for facilitating communication in various areas of exceptional children. Parent interviews required and evaluated. Prerequisite: SP 511 or equivalent. Credit, 3 hours.

522 Experience in Exceptional Child Clinics. Provides experience with exceptional children

in cooperating clinics, organizations, and institutions in Arizona which work with mentally retarded, orthopedic, sight, speech, hearing, bilingual, and other areas in Special Education. Preregistration necessary. Prerequisites: SP 594 (Summer Workshop in Exceptional Children), and teaching experience. Credit, 6 hours.

523 Participation with Gifted Children. Study and participation with gifted children in either a campus or community setting. Class for background study and research, and a special class of gifted children. Prerequisites: SP 594 (Summer Workshop in Exceptional Children), or experience in working with exceptional children in this category, and teaching experience. Credit, 6 hours.

524 Participation with Cerebral Palsy Children. Study and participation with cerebral palsy children in either a campus or community setting. Class for background study and research, and a special class of cerebral palsy children. Prerequisites: SP 594 (Summer Workshop in Exceptional Children), or experience in working with exceptional children in this category, and teaching experience. Credit, 6 hours.

530 Prevention of Emotional Disturbance. Programs and techniques for the prevention of maladaptive behavior and promotion of mental health in children and adolescents. Credit, 3 hours.

531 Behavior Management Approaches with Exceptional Children. Survey and evaluation of various behavior management approaches and techniques for dealing with maladaptive and/or inappropriate behavior of exceptional children in the school setting. Guidelines for dealing with specific problems. Prerequisite: SP 511 or equivalent. Credit, 3 hours.

533 The Bilingual Child. Mexican American and Indian children, including their educational needs, materials and methods appropriate to their backgrounds and language problems. Credit, 3 hours.

537 Methods of Teaching the Emotionally Disturbed. Special methods and techniques in

the development of a therapeutic educational atmosphere for socially-maladjusted and emotionally-disturbed children. Prerequisite: SP 436. Credit, 3 hours.

544 The Orthopedically Handicapped Child. Orthopedically handicapped children's needs and characteristics; appropriate materials and teaching methods; teacher qualifications; educability, definitions and terminology. Children with orthopedic, cardiac, tubercular and glandular handicaps. Credit, 3 hours.

555 The Child with Hearing Problems. Children with hearing disabilities of either a partial or complete nature, including their needs and characteristics, appropriate materials and teaching methods, teacher qualifications, educability, definitions and terminology. The hearing-handicapped child in the regular classroom situation and in special classes. Credit, 3 hours.

566 The Visually Handicapped Child. Visually handicapped children's needs and characteristics; appropriate materials and teaching methods; teacher qualifications; definitions and terminology. Credit, 3 hours.

578 Educational Procedures in Mental Retardation (Curriculum, Materials and Methods). Teaching the mentally retarded child, with emphasis on specific methods, materials of instruction and curriculum development. Meets state requirement for Special Education methods. Prerequisite: SP 512 or approval of instructor. Credit, 3 hours.

579 Vocational Programs for the Mentally Retarded. Curriculum planning and methods of teaching in secondary school and post-school programs for the mentally retarded. Work evaluation, work-study, sheltered employment and other aspects of vocational programs. Prerequisite: SP 312 or 512. Credit, 3 hours.

581 Methods of Teaching the Trainable Mentally Retarded. Development of materials, procedures and programs for the trainable mentally retarded, pre-school through

adulthood. Prerequisite: SP 312 or 512.

Credit, 3 hours.

Special Courses: 584, 590, 591, 592, 594. (See pages 46-47.)

Educational Technology and Library Science

Professors:

GERLACH (ED B-146), BENEDICT,
VERGIS

Associate Professor:
SATTERTHWAITE

Assistant Professors:
BOETTO, CLARK, HIGGINS,
KAUFFMAN, MOFFIT

Instructor:
MAMALIS

AUDIOVISUAL EDUCATION

AV 411 Audiovisual Materials and Procedures in Education. Role of learning and communication principles in the selection and/or preparation, evaluation and utilization of materials and equipment in instructional contexts. Practical, instructional and technological developments in education. Two lectures, 2 hours laboratory. Credit, 3 hours.

412 Audiovisual Practices. Exploration in depth of areas emphasized in AV 411. One lecture, 2 hours laboratory. Prerequisite: AV 411. Credit, 2 hours.

422 Radio and Television in Education: Utilization. Effective use of radio and television in education. Means of adapting materials for learning experiences. Credit, 2 hours.

433 New Instructional Media in Special Education. Selecting and utilizing audiovisual equipment and materials as instructional aids in teaching exceptional children. Aspects of instructional media pertaining to problems not

ordinarily encountered in regular classrooms. Two lectures, 2 hours laboratory. Credit, 3 hours.

455 Television and Cinema. Influence of contemporary TV and cinema on children and young people; these mass media as they affect education. Credit, 3 hours.

501 Audiovisual Methods of Teaching for In-Service Teachers. Newer media for instruction. Selection and evaluation of materials and procedures. Operation of equipment and production of materials. (This course may not be used for credit in a graduate major.) Credit, 3 hours.

502 Production of AV Materials for In-Service Teachers. Production of projected and non-projected audiovisual materials, including transparencies, slides, recordings. Utilization of AV materials in individual, small group and large group instructional settings. (This course may not be used for credit in a graduate major.) Credit, 3 hours.

522 Production of Audiovisual Materials II. Instruction in photography, sound, cinematography, television and graphics; application to the development of educational materials. For classroom teachers only. May be repeated for credit. Prerequisite: AV 411 or 501 or approval of instructor. Credit, 1 or 2 hours.

523 Listening and Sound in Education. Techniques for producing and recording sound as an instructional stimulus. Development of validated listening materials. Prerequisite: ET 501 or equivalent. One lecture, 2 hours laboratory. Credit, 2 hours.

524 Photography in Education. Theory and practice of still picture utilization in education. Production and validation of color and black and white photographs to implement instructional goals. Prerequisite: ET 501 or equivalent. One lecture, 2 hours laboratory. Credit, 2 hours.

525 Graphic Arts in Education. Theory and practice of utilizing graphic materials in education. Production and validation of graphic

materials for instruction. Prerequisite: ET 501 or equivalent. One lecture, 2 hours laboratory. Credit, 2 hours.

526 Cinematography in Education. Theory and practice of using motion pictures in education. Production and validation of instructional films. Prerequisites: AV 523 and 524, or approval of instructor. One lecture, 2 hours laboratory. Credit, 2 hours.

527 Educational Television: Production. Theory and practice of television in education. Techniques of script writing and program production. Production and validation of television programs. Prerequisites: AV 523 and 525, or approval of instructor. Credit, 2 hours.

528 Educational Media: Advanced Production. Development of skills in design and production of validated graphic, photographic, television and audio materials not covered in prerequisite courses. Special emphasis on multi-media techniques. One lecture, 2 hours laboratory. Prerequisites: AV 523, 524 and 525 or approval of instructor. Credit, 2 hours.

533 Management of Audiovisual Services. Procedures in the evaluation, selection, storage, retrieval, maintenance and budgeting of audiovisual materials and equipment. Competencies, functions, and responsibilities of the audiovisual coordinator of a school or district media program. Prerequisite: 9 hours in AV and/or ET, or approval of department chairman. Credit, 3 hours.

534 Instructional Resource Centers. Techniques of integrating library and audiovisual personnel and instructional media into unified instructional resource centers. Principles of personnel, space and finance supervision, and management. Procedures for faculty and program development within schools, districts and larger educational units. Prerequisite: AV 533 or LS 481. Credit, 3 hours.

560 Current Issues in Audiovisual Education. Identification and analysis of critical areas of media utilization in educational systems. Relationship to political, socio-economic and

cultural problems of society. Prerequisite: 9 hours in AV and/or ET. Credit, 3 hours.

EDUCATIONAL TECHNOLOGY

ET 501 Foundations of Educational Technology. Educational and psychological research findings in the development of technology. Survey of the product development cycle. Development of instructional specifications for educational products. Credit, 3 hours.

502 Designing Educational Environments and Materials. Formulation and development of materials and environments. Translation of instructional specifications into prototype environments and materials. Prerequisite: ET 501 or concurrent enrollment. Credit, 3 hours.

503 Quality Verification. Theory and practice of determining quality of materials and environments in all phases of the product-development cycle. Credit, 3 hours.

504 Installation of Innovations in Instructional Systems. Operations and procedures required for introduction of new instructional materials, environments, strategies. Development of director manuals. Staff training procedures. Credit, 3 hours.

505 Cybernetics and Education. Theory and technology of objectivated systems. Specific application to development of instructional materials and environments. Prerequisites: ET 501, 503. Credit, 3 hours.

507 Technology of Individually Prescribed Instruction. Capabilities of equipment which is useful in individualized instruction. Methods and techniques for adapting equipment to meet specific needs. Materials problems peculiar to the process of individualizing instruction. Prerequisite: ET 505 or approval of department chairman. Credit, 3 hours.

510 Information Science I. Information science as a field of study; the role of major information and documentation centers. Overview of approaches and techniques developed to meet the information demands of modern

technological societies. Credit, 3 hours.

521 Programmed Instruction. Constructing, testing and revising a programmed learning sequence. Application of principles of programmed instruction to both printed and nonprinted media. Prerequisite: admission to the program or approval of department chairman. Credit, 3 hours.

522 Computers in Education. Application of computer technology to instructional and administrative functions. Orientation to capabilities of computers and technological support of pupils and personnel. Credit, 3 hours.

523 Computer Programming for Instruction. Author languages and programming techniques for instructional purposes. Student acquires sufficient competence to develop a major computer controlled program of instruction as a final project. Credit, 3 hours.

560 Current Issues in Educational Technology. Critical analysis of current literature. Assessment of current practices in educational product development. Prerequisites: ET 501, 502, 503, 504. Credit, 3 hours.

INSTRUCTIONAL MATERIALS

IM 311 Children's Literature. Survey of modern and folk literature for elementary school children; elements of a good book for children; techniques for promoting appreciation of literature. Provides background for supplementary materials in all areas of the school curriculum. Credit, 3 hours.

533 Evaluation of Children's Literature. Social and educational concepts and values expressed in literature. Standards of literary criticism. Credit, 3 hours.

LIBRARY SCIENCE

LS 313 Library Skills for Teachers. A classroom teacher's introduction to school library materials, organization and services. Most frequently used ready-reference materials and procedures for using the library in teaching.

No credit on Library Science minor. Credit, 3 hours.

423 Books, Libraries and Society. History of books and libraries as related to society, and a study of librarianship as a profession. Credit, 3 hours.

440 Classification and Cataloging. Principles of subject classification, assigning Cutter numbers, subject tracings, compiling shelf list, cataloging library materials. Credit, 3 hours.

461 Selection of Library Materials. Criteria, problems and policies in the selection of materials for the school and public library. Guides and aids, publishers, dealers and reading interests. Credit, 3 hours.

463 Library Materials for Children. Books and related materials for children's libraries and the elementary school program. Criteria for selection and procedures for integrating vital materials into the school curriculum and/or free-reading program in both the school and public library. Prerequisite: LS 461 or approval of instructor. Credit, 3 hours.

464 Library Materials for Adolescents. Books and related materials for youth libraries and the secondary school program. Criteria for selection and procedures for integrating vital materials into the school curriculum and/or free-reading program in both the school and public library. Prerequisite: LS 461 or approval of instructor. Credit, 3 hours.

471 Basic Reference Resources. Content and use of the basic types of ready-reference works such as dictionaries, encyclopedias, year-books, biographical dictionaries, geographical sources, directories of agencies, handbooks, manuals, serials, indexes, bibliographies, government publications and audiovisual sources. Credit, 3 hours.

481 Library Administration. Organization and management of the school and public libraries; their backgrounds, services, functions, personnel, materials and equipment. Prerequisites: LS 423, 440, 461 and 471. Credit, 3 hours.

493 Library Science Workshop. Selected library problems, directed by the regular staff and/or visiting specialists, for in-service librarians with no fewer than 15 credits in Library Science. Others by approval of the instructor. Credit, 3-6 hours.

511 Cataloging II. Problems related to contemporary cataloging, its structure and purpose as a function of bibliographical control. Prerequisites: LS 440. Credit, 3 hours.

522 Reference Resources II. Critical evaluation of the most frequently used reference materials in humanities, sciences and social sciences. Prerequisites: LS 471. Credit 3 hours.

531 Instructional Materials Centers. Organization and management of the library as an integral part of an instructional materials center. Prerequisite: Library Science minor. Credit, 3 hours.

533 Current Library Problems. Professional reading and discussion on current issues in librarianship as related particularly to supervision in school districts and/or public library systems. Prerequisite: LS 481 or approval of instructor. Credit, 3 hours.

544 Reading and Communication. Improvement and encouragement of reading interests and habits as related to the use of library materials and resources. Prerequisite: LS 461, 463 and/or 464. Credit, 3 hours.

Special Courses: See pages 46-47.

College of Engineering Sciences

LEE P. THOMPSON, PH.D.

Dean

Purpose

The purpose of the College of Engineering Sciences is to provide a university education of such fundamental background and scope that a student may achieve competency in one of the fields of engineering, agriculture, technology or construction. Every effort is made to carry on a well-rounded, well-integrated program which will not only give the student proficiency in his professional field but also will develop character, judgment, ideals, breadth of view, general culture and physical well-being.

The Research Center provides an opportunity for students to augment their theoretical knowledge with research, development and experience.

All courses taken at Arizona State University in fulfillment of the requirements for graduation by students enrolled in the College of Engineering Sciences are to be taken on a graded basis.

Organization

The College of Engineering Sciences is organized as follows:

School of Engineering

Engineering Science Core

Options:

CHEMICAL ENGINEERING

CIVIL ENGINEERING

ELECTRICAL ENGINEERING

ENGINEERING MECHANICS
AND MATERIALS

ENGINEERING SCIENCE

INDUSTRIAL ENGINEERING

MECHANICAL ENGINEERING

Division of Agriculture

BIO-AGRICULTURAL SCIENCES

ENVIRONMENTAL RESOURCES
IN AGRICULTURE

AGRICULTURAL AND RESOURCE
ECONOMICS

AG-INDUSTRY

SPECIAL PROGRAMS

Division of Construction

CONSTRUCTION CORE

Options:

HEAVY CONSTRUCTION

INDUSTRIAL CONSTRUCTION

SYSTEMS BUILDINGS

MECHANICAL CONSTRUCTION

ELECTRICAL CONSTRUCTION

EQUIPMENT AND MATERIALS
CONSTRUCTION

Division of Technology

AERONAUTICAL TECHNOLOGY

ELECTRONIC TECHNOLOGY

GRAPHIC COMMUNICATIONS

INDUSTRIAL DESIGN

INDUSTRIAL TECHNICAL EDUCATION

MANUFACTURING TECHNOLOGY

MECHANICAL TECHNOLOGY

Computer Center

Research Center

Degrees

Bachelor's Degree. The completion of a four-year curriculum in agriculture, technology and construction leads to the degree of Bachelor of Science. The completion of a four-year curriculum in engineering leads to the

degree of Bachelor of Science in Engineering. General fields for this degree are: chemical engineering, civil engineering, electrical engineering, engineering mechanics, engineering science and mechanical engineering.

Master of Science in Engineering Degree. The Master of Science in Engineering degree is awarded upon successful completion of prescribed graduate level coursework, engineering projects and research endeavor. The student's program of study is administered under an advisor with the approval of the Dean. Areas of specialization available are: chemical, civil, electrical, industrial, mechanical, engineering mechanics and engineering science. Within programs of study, interdisciplinary emphasis can be arranged.

Master of Science Degree (Engineering). This program is designed to provide the competent student in engineering or other selected fields an opportunity to specialize in a particular subject area within engineering. Normally this objective may be attained through the satisfactory completion of graduate-level coursework, engineering projects and research endeavor.

Master of Science Degree (Agriculture). This program provides competent students with opportunities to specialize in selected programs designed to serve the needs of agriculture in relation to business and industry.

Master of Science in Technology Degree. This program provides both the technical background and the professional education experience for post-secondary technical teachers.

Doctor of Philosophy Degree (Engineering). The degree Doctor of Philosophy is awarded in engineering upon the satisfactory completion of an approved program of graduate

study and research. For specific reference to this degree, see the "Graduate College" section.

General Studies. Higher education should provide the student not only with competency in his chosen subject field, but also with experiences which facilitate the student's growth in ability to perceive significant relationships, to make intelligent value judgments, to express himself with ease, clarity and good taste, and to develop the qualities of character and personality requisite for a successful career. The development of moral, ethical and social concepts, along with a sound professional attitude, is required. It is expected that the attainment of an interest and pleasure in the above pursuits will be an inspiration to continued study. Courses are selected with the aid of an advisor to provide planned sequences and to place emphasis on the interrelationships that exist among fields of knowledge.

The General Studies requirements for each of the curricula offered in the College of Engineering Sciences, *except engineering* (see additional provisions below), include selections from the following:

BEHAVIORAL AND SOCIAL SCIENCES 8*
Aerospace studies, agriculture, anthropology, business administration, cultural geography, economics, education (educational foundations), engineering, health education, history, home economics, mass communications, military science, political science, psychology (PX courses only), sociology.

HUMANITIES AND FINE ARTS 8*
Architecture, art, dance, theatre, English, foreign languages, interdisciplinary humanities, music, philosophy, speech.

SCIENCES AND MATHEMATICS 8*
Botany, chemistry, engineering, geology, mathematics, physical geography, physics, psychology (PY courses only), zoology.

GENERAL STUDIES ELECTIVES 12*
*Minimum semester hours.

The humanities and social science requirements for students pursuing the Bachelor of Science in Engineering degree are more closely structured than for other degree programs. Seventeen semester hours minimum are required in humanities and social sciences under the following special provisions:

1. A minimum of 8 semester hours in humanities and 8 semester hours in social sciences is required.
2. It is required that at least 6 of the 17 semester hours total be 300- or 400-level courses.
3. It is required that the student select a two-course sequence (6 hours or more) from either Group A or Group B listed below and at least one course (3 hours or more) from the other Group (A or B). The sequence cannot include EC 201.
4. EC 201 Principles of Economics is a required selection in the social studies category.
5. Special interests of the student may be satisfied by selection of the remaining minimum of 5 hours from Groups A, B, C, or D (subject to requirement No. 2).

GROUP A:
Humanities and Fine Arts
AP 100, 101, 300, 301, 313*, 314*; EN 103, 105, 201, 202, 221, 222, 313, 358; FL 100; HU 101, 102, 301*, 302*, 402; MU 107; PI 401, 402, 403, 404.

GROUP B:

Behavioral and Social Sciences

AE 300; AN 102, 311*, 322, 323, 331, 351*, 411, 412, 416*, 417, 479; CE 371; EC 201, 202; EF 111, 322, 333, 422; ES 402; GC 121, 241, 351, 361, 401, 441; HI 101, 102, 103, 104, 303*, 304*, 305*, 306*, 343*, 344*, 409, 410; MC 120, 314; ME 201, 300, 301, 302, 401; PS 100, 200, 250, 260, 420, 425, 426, 427, 430; PX 100, 315, 341, 342, 350, 414; SF 411, 422; SO 301, 332, 333, 351, 352, 360, 410, 415, 440, 454, 483.

NOTE: Students with a good high school background in American and western civilization history are encouraged to take eastern civilizations or Latin American history.

*Recommended sequences

GROUP C:

Humanities and Fine Arts

Any AH, AP, HU course.

Any DR course except 113, 213, 313 and repeated for credit courses.

Any EN course except 101, 102, 104, 111, 112, 211, 212, 471, 480, 485.

Any Foreign Language literature course in the 300 series.

Any MU course except 100, 101 and teaching methods.

Any PI course except 104.

SE 120, 214, 300, 310, 312, 400, 411.

GROUP D:

Behavioral and Social Sciences

Any AN, GC, EF, SF, HI, MF, PS, PX course; GB 305; Any SO course except 271, 305, 341, 478, 479, 491, 494.

English Proficiency Requirement. English proficiency is expected and may be satisfied by completing EN 102 or EN 104.

Honors Program. Students in the College of Engineering Sciences are eligible to partici-

pate in the Honors Program as administered by the School or Division in which the student is enrolled. See page 46 for further information.

School of Engineering

LEE P. THOMPSON, PH.D. *Director*

Purpose. The Engineering Program seeks the attainment by each graduate of certain broad objectives, and it is designed to make effective a philosophy of education for careers in applied science, engineering and industry for leadership. Society's needs in the decades ahead call for engineering talent on a scale not previously seen. Engineering education should, therefore, provide an opportunity for the optimum development of a wider variety of activities, aptitudes and interests, including moral, ethical and professional concepts.

The curricula and courses offered are designed to meet the needs of the following students: (1) those who wish to obtain a Bachelor of Science in Engineering degree and who plan careers in fields where science, mathematics and analytical methods are of special value; (2) those who wish to do graduate work in engineering; (3) those who wish one or two years of training in mathematics, applied science and engineering in preparation for a technical program; (4) those who desire pre-engineering for the purpose of deciding which engineering field to undertake or those who desire to transfer to another college or university; (5) those who wish to take certain electives in these fields while pursuing another curriculum in the University.

Admission. Students who wish to be admitted to full freshman standing in Engineering should present certain secondary school units in addition to the minimum University requirements. A total of 3½ units is required in mathematics. Included must be: advanced algebra, geometry and trigonometry. Calculus is recommended. The laboratory sciences chosen must include at least one unit in physics and one unit in chemistry. One unit of biology is strongly recommended.

Students who have omissions or deficiencies in subject matter preparation may be required to complete additional university credit coursework which may not be applied toward an engineering degree. One or more of the courses — MA 117 College Algebra, MA 118 Trigonometry, PH 111 General Physics, EN 101 College English, CH 113 General Chemistry — are usually taken to satisfy omissions or deficiencies.

Credit is granted for transferred courses which are substantially equivalent to corresponding courses in an engineering program, subject to grade and senior resident requirements. Such credits are provisional and become final only after the student has demonstrated his ability to do satisfactory work. Credits will be accepted by transfer from a junior college to meet lower division requirements only. The status of a student and the specific credits acceptable toward his degree are determined by the Dean of the College.

Well-prepared students can usually complete the plan of study leading to the degree of Bachelor of Science in Engineering in any of the engineering curricula in four years, or fewer than four by attending Summer Sessions. Many students, however, may find it advantageous or necessary to devote more than four years to the undergraduate engineering programs of study by pursuing, in

any semester, fewer studies than are regularly prescribed. In cases of inadequate secondary preparation, poor health or financial necessity requiring much time for outside work, the undergraduate course should be extended to five years or longer. A student who so desires may devote additional time to his undergraduate work and include additional instruction in the humanities, social sciences, physical sciences or mathematics.

Organization. The engineering core consists of a highly correlated group of courses of fundamental importance and basic concern to engineers. It constitutes a broad base of science, mathematics and engineering upon which the various fields of specialization are founded. Instructional patterns are basically variations of a single curriculum, and the student is allowed considerable latitude in developing an instructional pattern to fit his particular interests. In each of the several fields of specialization, the scientific knowledge and techniques are applied and further developed through analysis, synthesis and design in a definite engineering discipline. For convenience, all of the fields of specialization offered are designated as KE, CE, EE, EM, IE and ME. In addition, an Engineering Science (ES) program accommodates those students whose educational objectives require more flexibility than is possible in the engineering field programs. Thus, to reach a given objective, a student in the ES program would complete the engineering core and then, with the aid of an advisor, select one of the approved patterns of coursework to complete the degree requirements.

Bachelor of Science in Engineering. The satisfactory completion of a curriculum of a minimum of 127 semester hours, including general studies, the engineering core, and

both required and elective courses of study in the ES program or in a field of specialization, leads to the degree of Bachelor of Science in Engineering. Where omissions or deficiencies exist, i.e., in chemistry, English, physics or mathematics, the student will need to complete more than the minimum of 127 semester hours.

The principal fields of specialization in the engineering curriculum are devoted to the basic sciences, mathematics, the fundamentals of engineering science and their application to the solution of engineering problems. These courses are not training courses for any of the mechanical or manipulative skills, but, rather, are planned to provide preparation for development, design, research, graduate work, and, with certain electives, for operation, production, testing, maintenance and management.

In any specialization the degree requirements consist of the engineering core, the general studies and the courses in the field of specialization.

For assistance and counsel in planning a program, each student will be assigned an advisor from the faculty in his special interest field. In addition, a Student Advisement Coordinator is available for counsel and assistance.

The Engineering Core. The engineering core presents unifying concepts of engineering in a group of engineering-oriented, science-based courses and a sequence of supporting courses in basic science and mathematics fundamental to the field of engineering. The objectives are two-fold:

- (1) To provide the student with an understanding of idealized models in the context of realistic engineering situations.
- (2) To provide the student with an under-

standing of the relative utility of mathematical and empirical approaches in predicting the consequences of physical interactions and in solving realistic engineering problems.

Course content is designed to introduce the student to these two aspects of engineering in sufficient depth to provide him with a basis: for working in his field of specialization; for extending himself into engineering activity outside his chosen field of specialization; and for choosing his technical electives to emphasize preparation for a career in engineering application or research.

Engineering Core Requirements (Minimum).

	<i>Semester Hours</i>
MA 120 Analytical Geometry and Calculus I	5
MA 121 Analytical Geometry and Calculus II	5
MA 212 Analytical Geometry and Calculus III <i>or</i> ES 345 Methods in Engineering Analysis (5)	5
CH 114 General Chemistry for Engineers <i>or</i> ES 118 Chemical Founda- tions of Engineering (4)	4
ES 102 Introduction to Engineering . . 2	
ES 104 Engineering Graphics	2
ES 122 Computer Programming 2	
ES 201 Mechanics and Heat	4*
ES 202 Electrical Science	4*
ES 203 Engineering Wave Phenomena	2*
ES 211 Engineering Mechanics (Statics)	2

	<i>Semester Hours</i>
ES 300 Economic Analysis for Engineers	2
<i>or</i> ES 304 Atomic and Nuclear Principles (2)	
ES 312 Engineering Mechanics (Dynamics)	3
ES 313 Mechanics of Materials	4
ES 330 Electrical Networks	4
ES 331 Electronic Engineering	4
<i>or</i> ES 361 Measurement Systems Engineering (4) <i>or</i> ES 364 Chemical Process Instrumentation (3)	
Applied Mathematics Course	3
(ES 340, ES 344, ES 346, ES 348, or MA 362)	
ES 350 Structure and Properties of Materials	3
ES 371 Fluid Mechanics	4
ES 381 Thermodynamics	3
ES 400 Engineering Communications	3
Engineering Analysis and/or Synthesis Elective	3
Engineering Design and/or Systems Elective	3

*Note: PH 115, 116, 117 and 118 will satisfy the requirements of ES 201, 202 and 203

Except as noted below, the engineering core is common to all patterns and fields of specialization. This arrangement gives the student time to become adjusted, and to choose that for which he is best adapted. Counseling is provided in order that the student may be aided in making his choice.

To obtain the necessary chemical science background, chemical engineers may use the following alternatives: CH 117, 118 for

ES 118; CH 417, 418 for ES 350 and ES 304; KE 331 for ES 371; and KE 342 for ES 381.

Engineering students will complete the engineering core courses, the general studies courses (including a total of 17 semester hours minimum from two categories — behavioral and social sciences, and the humanities and fine arts), and the field requirements. Required and elective courses for each field are listed below and changes may be made only with the approval of the Dean.

Technical electives are selected with the approval of the student's faculty advisor and may be made from 300-level courses or above in engineering, mathematics, the sciences or business administration.

Any student whose written or spoken English in any course is unsatisfactory may be reported by the instructor to the Dean. The Dean may assign supplementary work, including additional coursework, consistent with the needs of the student. The granting of a degree may be delayed until the work is completed satisfactorily.

Prior to enrolling in courses at the 300-level and above, all engineering students in good academic standing must secure the approval of their advisor. Students who are not in good academic standing must secure the approval of their advisor *and* the Dean prior to enrolling in courses at the 300-level and above.

All the undergraduate options of engineering — chemical, civil, electrical, mechanical, engineering mechanics and the regular patterns of engineering science — are accredited by the Engineers' Council for Professional Development (ECPD). Since the engineering-based, interdisciplinary programs lead to professional work in fields other than engineering, evaluation by ECPD has not been requested. The first

degree program in industrial engineering — the Master of Science in Engineering — is also accredited by ECPD.

Chemical Engineering

The chemical engineer is generally concerned with processes involving a chemical change or separation. He applies science, especially chemistry and physics, to the development, design and operation of processes and medical equipment. Mathematics is his tool and economics his guide in practice. His training often leads to research and development activities for which graduate study is desirable, but the bachelor's degree has sufficed for the majority. Since chemistry is involved in most activities, the chemical engineer is found in a diversity of industries which manufacture metals, ceramics, space propellants, solid state devices, petroleum products, plastics, foods, drugs, medical equipment, fermentation products, petrochemicals and conventional chemicals. Extractive metallurgy, biomedical and nuclear engineering are chemically based fields which come within the realm of chemical engineering. Training in chemical engineering provides a broad background which prepares one for a variety of occupations including environmental control, oceanographic studies, biomedics, mathematical modeling and computerized design.

Chemical engineering also offers an interdisciplinary program in biomedical engineering for students enrolled in other engineering majors. A strong minor program can be developed from the following courses: KE 411, 413, 492, 513, 515, 517 along with research and these selections.

Chemical Engineering Core

	<i>Semester Hours</i>
KE 211 Chemical Process Calculations	2
KE 331 Transport Processes	(4)
KE 332 Chemical Engineering Operations	(4)
KE 333 Transport Phenomena Laboratory	1
KE 342 Applied Chemical Thermodynamics	(3)
KE 442 Chemical Reactor Design	(3)
KE 451, 452 Chemical Engineering Laboratory	4
KE 461 Process Control	3
KE 462 Process Design	4
CH 117, 118 Chemistry I, II	(4) 2
CH 119 or CH 335, 443 Chemistry Laboratory	2
CH 120 Chemistry Laboratory II... or Technical Elective for those electing ES 118	2
CH 317, 318 Chemistry III, IV	6
CH 417, 418 Chemistry V, VI ..	(6)
Approved Technical Electives	4

The chemical engineering core gives a fundamental chemical engineering education with a choice of electives to satisfy the student's interests. Specialization may be obtained in mission oriented fields by a choice of appropriate technical electives in that area with the advice and consent of the advisor. When the special interests of the student necessitate a broader science background, a maximum of two courses in the chemical engineering core may be replaced

by electives from biomedical engineering if approved by the advisor and faculty chairman.

BIOMEDICAL ENGINEERING: KE 411, 413, CH 461, 462, 467, ZO 201, 360, or EM 372

Electives available for specialization are listed below:

CHEMICAL PLANT ADMINISTRATION: GB 305, MG 301, MK 300, EC 202

COMPUTERIZED DESIGN AND OPTIMIZATION: ES 422, 449, KE 481

ENGINEERING SCIENCE: EM 372, ES 444, ME 488, 489, MA 460

ENVIRONMENTAL CONTROL: CE 361, 362, 462, 464, 465, SO 432

MATERIALS: ES 350, EM 450, 451, 452, KE 423

MATHEMATICAL APPLICATIONS: MA 342, 460, ES 344, 442, 444

NUCLEAR ENGINEERING: ME 411, 412, 413

PROCESS SYSTEMS: ES 342, 344, IE 473, 475, 476

SIMULATION AND CONTROL: IE 463, ME 465, KE 481, EE 425, 455, 480

Civil Engineering

Civil engineers are responsible for the planning, research, design, construction and operation of many structural, urban and environmental projects which form the basis of our modern civilization. These include buildings, bridges, highways, dams, canals, irrigation projects, water and waste treatment plants and various multipurpose systems. Education in this field is founded on scientific fundamentals with extensive training and practice in one or more fields of professional specialization.

Civil Engineering Core

	<i>Semester Hours</i>
CE 241 Surveying	3
CE 312 Engineering Materials	2
CE 321 Structural Mechanics	(4)
CE 322 Fundamentals of Structures	(4)
CE 361, 362 Environmental Engineering	5
CE 372 Transportation Engineering .	3
CE 381 Applied Fluid Mechanics...	3
CE 451 Soil Mechanics	3
Courses in Elective Area	10

Typical engineering courses for each civil engineering elective area are listed below. Final selection will be made by the student with the approval of his advisor. In addition, certain areas can be strengthened by choosing general studies courses from the recommended lists. To insure completion of a degree in the minimum number of hours, students are advised to select their elective area and file their program of study at least one semester before taking such courses. HU 101 and 102 or HU 301 and 302 are recommended for all elective areas.

General — Requires (1) an approved science course; (2) at least two design courses chosen from the following list: CE 423, 452, 466, 475, 481; and (3) approved technical electives.

Urban Systems — CITY PLANNING, TRANSPORTATION, HIGHWAYS. CE 371, 466, 471, 474, 481; IE 473; (ES 300, 340). *General Studies:* AN 101; SO 301; PX 100; GC 361; EC 451

Environment — SANITARY ENGINEERING, PUBLIC HEALTH, INDUSTRIAL HYGIENE.

CE 461, 463, 464, 466, 471, 481; MI 201; CH 231; BI 330; (ES 340). *General Studies:* AN 101; PX 100; SO 301

Water Resources — HYDRAULICS, HYDROLOGY, WATER SYSTEMS ANALYSIS. CE 463, 481, 495; IE 473; GL 301; (ES 300, 340). *General Studies:* EC 452; PS 100, 425; SO 301, 432

Geotechnics — SOIL MECHANICS, FOUNDATIONS, GEOLOGICAL ENGINEERING. CE 452, 453, 473; GL 301, 310, 321, 324, 410, 418, 435, 446; (ES 300, 348)

Structures — ARCHITECTURAL, AEROSPACE, STRUCTURAL MECHANICS. CE 423, 431, 432, 438; AT 371, 372; GL 301; EM 415; ME 331, 427; (ES 344, 346)

Construction — CE 344, 452, 475; (ES 300); GL 301; CO 174, 383, 411, 462, 484, 496. *General Studies:* AP 100

Integrated BSE-MSE Program. This program is for academically qualified students who desire the most efficient program to meet the rapidly increasing demands of the profession for engineering graduates with advanced training. Students qualified to choose this program are assigned a faculty committee to assist them in selecting an appropriate package of courses for both the bachelor's and master's degrees. Fields of professional specialization may be selected from the above specific areas of study.

Electrical Engineering

Many modern scientific and engineering developments are either essentially electrical in character or depend on electrical equipment and techniques. The field is very broad since it enters into much of industry where power is utilized, intelligence is transmitted,

or control is exercised over physical, chemical or mechanical operations. Areas of current interest include solid state electronic devices, computer system design, computer science, communications, control systems, lasers, power systems, medical electronics, electromechanics, electronic instrumentation, space electronics, underseas electronics, network analysis and synthesis, energy conversion and instrumentation for environmental protection, and electronic crime prevention techniques.

While all students in electrical engineering pursue a common program in fundamentals, opportunity for study in greater depth in various technical areas is provided through a choice of technical areas. These technical electives are based on a common core of electrical engineering fundamentals. The electrical engineering core is in addition to, and integrated with, the engineering core.

Electrical Engineering Core

	<i>Semester Hours</i>
MA 212 Analytical Geometry and Calculus III	(5)
ES 304 Atomic and Nuclear Principles	(2)
ES 331 Electronic Engineering .	(4)
MA 362 Engineering Mathematics	(3)
EE 302 Electrical Networks	(3)
EE 332 Electronic Engineering	4
EE 341 Electromagnetic Fields	3
EE 357 Semiconductors and Devices	3
EE 362 Electromechanics	4
EE 401 Electrical Networks	4
EE 480 Feedback Systems	(4)

EE 496 Professional Seminar 0
 Approved Technical Electives,
 Minimum Total 12

Approved Technical Electives (12 Semester Hours)

Technical electives may be selected from one or more of the following technical areas.

- A. APPLIED MATH. EE 320, 426, 434, 483; ES 340, 344, 441, 443, 445, 446; MA 342, 426, 442, 461, 462, 464, 465
- B. ANTENNAS AND MICROWAVES. EE 441, 443, 445
- C. LASERS AND COHERENT OPTICS. EE 434, 448
- D. SOLID STATE ELECTRONICS. EE 431, 432, 433, 434, 435; KE 423
- E. NETWORKS. EE 402, 405, 406, 425, 445, 490, 495
- F. CONTROLS. EE 320, 420, 425, 455, 483, 484; ES 441, 443
- G. COMMUNICATIONS. EE 455, 456, 483, 484; ES 441
- H. DIGITAL SYSTEMS. EE 320, 420, 421, 427
- I. COMPUTER SCIENCE. EE 320, 426; ES 422, 423
- J. DIGITAL CIRCUITS. EE 320, 422, 423.
- K. POWER SYSTEMS AND MACHINERY. EE 461, 471, 472

With the approval of the student's faculty advisor, technical electives may also be chosen from other courses in engineering, mathematics, the sciences and business administration at or above the 300-level.

Engineering Science

The engineering science program accommodates students whose education objectives require more curricular flexibility than traditional engineering curricula generally permit. Some students regard engineering as primarily a preparation for professional engineering where skills in the application of science and of both physical and social technologies can be brought to bear on problems of larger scope. What these students seek is frequently not well served by branching from existing engineering disciplines but rather by a merging of principles and approaches drawn from all fields of engineering and other disciplines. As an answer to this need, two types of course arrangements are available: (1) regular patterns of engineering science; and (2) engineering-based interdisciplinary patterns. Both are developed beyond the engineering core.

Both the regular patterns of engineering science and the engineering-based interdisciplinary patterns must be approved by the Engineering Science Advisory Council. Each pattern consists of both required and elective courses. A minimum of three semester hours of coursework must be included in each pattern in engineering analysis and/or synthesis to satisfy this requirement in the engineering core. Some typical patterns that have received approval are shown below. Others may be designated as student needs appear.

Regular Patterns of Engineering Science

Bio-engineering. Bio-engineering bridges the gap between the engineering and physical sciences on the one hand and the life sciences

on the other, and draws upon each area for support. The merging of physical and engineering sciences with the life sciences began during World War II with the occasional collaboration on a new instrument between someone who had an educational background in engineering or one of the physical sciences and an associate from medicine or one of the basic biological sciences. The present multidisciplinary approach to the solving of problems in medical treatment and research has evolved from such exchanges of information. Today, engineers, physicists and mathematicians routinely join with the biologist and physician in developing techniques, equipment and materials. The need for advanced study beyond the bachelor's degree is acute in bio-engineering since the field includes a depth of knowledge from two diverse disciplines.

Semester Hours

Required courses: CH 331, 332, 461; ZO 201, 360; IE 425 or 480; KE 411, 413; ES 492 28
 Approved engineering electives from an area of specialization 9
 Note: ES 361 or 364 must be selected in the Engineering Core.

Computer Science. The development of computer technology has had a tremendous impact on engineering education and engineering practice. This impact is expected to be even greater in the future as the full potential of modern computing systems and techniques is realized. The computer science pattern is designed to give the engineering student a good background in computer programming. Emphasis is on the structure of information, use of the computer in solving engineering problems and nature of information processing system.

Semester Hours

Required courses: EE 320, 325; IE 473 or 476; 475; ES 322 or 344 or MA 464; ES 422 or 424; 423, 441, 492. . 27
 Approved engineering electives from an area of specialization 10
 Note: ES 340 and 361 must be selected in the Engineering Core.

Engineering Mathematics. The engineer of the future, as in the past, will utilize mathematics in much of his work. In research, design, production or even in the solution of social problems, the rapidly decreasing time lag between discoveries and applications imposes ever-increasing demands upon the mathematical preparation of the engineer. What was thought to be abstract or pure mathematics only 15 years ago is routinely used by engineers today. An engineer interested in the applications of mathematics, therefore, must have preparation in the abstract fields of modern mathematics which may be applied in the future as well as in the applied mathematics of the present. This pattern combines pure mathematics, applied mathematics and courses from a field of specialization in order that the student will be well prepared to work in engineering or to continue study at the graduate level in mathematics or engineering.

Semester Hours

Required courses: MA 370, 470, 474; ES 344 or MA 464; ES 441 or 442; ES 444 or MA 342; ES 445 or MA 461; ES 446 or MA 462; ES 492 . . 27
 Engineering Electives from a field of specialization 10
 Note: ES 340 must be selected in the Engineering Core.

Pre-Professional Industrial Engineering. The pre-professional industrial engineering pattern is intended for students interested in graduate work in industrial engineering as part of a five-year continuum. The professional degree is the Master of Science in Engineering degree with an industrial engineering major. The pre-professional option provides for an integrated five-year program of study and consequently permits more specialization at the graduate level. To qualify for this pattern, a student must have completed 60 semester hours of applicable course work, with a cumulative grade point average of at least 3.00. Such application must be approved by the Industrial Engineering Faculty.

Admission to this pattern does not automatically qualify the student for acceptance into the fifth-year graduate program since another evaluation of the cumulative grade point average will be made at the end of the fourth year, but it is expected that most qualified students will earn both the BSE and MSE degrees within a five-year period.

*Semester
Hours*

Required courses: AC 332 or EE 320 or ME 332; IE 422 or 474; 431; 473 or 476; 425 or 461 or ES 423; MA 362 or 460 or ES 346 or MA 464; ES 322, or IE 475; ES 441, 442, 492 30

Approved engineering electives from an area of specialization 7

Note: ES 300, 340 and 361 must be selected in the Engineering Core.

Measurement Systems Engineering. Today's technology in all fields exceeds the capabilities of purely theoretical approaches. Experimental work of increasingly sophisticated nature is necessary to study phenomena in all branches of engineering. The engineer-

ing of these measuring systems is a new, exciting and challenging field. Measurements are made in all disciplines, and all disciplines contribute to the design of measuring systems. Thus measurement engineering is among the broadest and most general areas of engineering.

*Semester
Hours*

Required courses: EE 302; 341 or ME 487; EE 362; 483 or ES 340; ME 463 or 462; 465 or EE 480; ME 488; EM 452 or EE 357; ES 492 . . . 28

Approved engineering electives from a field of specialization 9

Note: ES 304, 346 and 361 must be selected in the Engineering Core.

Nuclear Engineering. Nuclear engineering is concerned with the release, control and utilization of nuclear energy. This includes the understanding of basic principles which can be used for the design and application of nuclear reactors for electrical power generation, marine propulsion, sea water desalting and power systems for outer space. Advanced research methods are also studied using neutron activation analysis and radioisotope techniques in the fields of medicine, biology, agriculture and industry. The curriculum is deeply rooted in the thermal and electrical sciences as well as nuclear science and is intended to prepare the student for careers in industry or for graduate study.

*Semester
Hours*

Required courses: ES 361; ME 382, 411, 412, 413, 415, 488; ES 492. . . 25

Approved engineering electives from a field of specialization 12

Note: ES 304, 331 and 346 must be selected in the Engineering Core.

Operations Research. The operations research pattern is designed to enable the engineering science student to formulate operational problems both of an engineering and socio-economic variety. Emphasis in the program is on the quantitative tools and techniques used by operations researchers in solving such problems. Problems are described in a decision-theory framework involving objectives and constraints. The constraints typically imposed result from budgets, corporate policy, and federal regulations. It is the intent of this pattern to introduce to the student sufficient material so that he will be able to approach problems quantitatively within a given framework.

*Semester
Hours*

Required courses: IE 431, 461, 473, 476; MA 460; ES 322 or IE 475; ES 441, 442, 492 27

Approved engineering electives from an area of specialization 10

Note: ES 300, 340 and 361 must be selected in the Engineering Core.

Production Systems. The production systems pattern is designed for students who wish to pursue an industrial engineering career concerned with the design, improvement and installation of integrated systems of men, materials and equipment. The pattern is designed to give a firm engineering and mathematical foundation upon which is built the ability to analyze current systems for improvement and to predict the consequences of decisions prior to their implementation. The ability to apply the digital computer in the analysis process is stressed and developed. The term "production" is used in its broadest sense, and would be applicable to a wide spectrum of activities, typical of which would be transportation optimization, bank activity

analysis, hospital procedures improvement, manufacturing systems and processing activities.

*Semester
Hours*

Required courses: AC 332; ME 332;
IE 422 or 474; 431, 461; 473 or
476; ES 322, 442, 49227

Approved engineering electives from
an area of specialization10

Note: ES 300, 340 and 361 must be selected in
the Engineering Core.

Urban Systems Engineering. Frequently civilizations are measured by their cities. For the past 100 years America has been moving toward urbanization, and forecasts indicate that this trend will likely continue for the next two decades. The problems of urbanization extend over a wide range of physical, social and economic conditions. These problems are also affected by scale. Thus an urban area with a concentration of 1,000,000 people is not always functionally the same as another area with a population of 100,000. The problems of urban areas are highly interrelated and interdisciplinary. This pattern provides a fundamental education in the engineering sciences and a broad spectrum of courses in the humanities and the social sciences. From these, the engineer can move into such areas as urban engineering, transportation planning, environmental engineering, city planning, urban management and decision making, or perhaps serve the electorate directly.

*Semester
Hours*

Required courses: ES 442; CE 371, 461,
472; IE 431, 473, 476; ES 49224

Approved engineering electives from
an area of specialization13

Note: ES 300, 340 and 361 must be selected in

the Engineering Core. Also, PX 100 and SO 301 must be selected as a part of the General Studies requirement.

Engineering-Based Interdisciplinary Programs

Business and Pre-Law. This pattern has been specifically designed to accommodate those students who, after completion of their bachelor's degree in engineering, intend to earn a graduate degree in business administration or law. The success with which engineers have risen to positions of leadership in business and government is well known. It is predicted that with the rapid increase in technological advance on every hand, opportunities for engineers to enter business or legal careers will be enhanced to an even greater degree in the future. Students who complete this pattern may complete requirements for the Master of Business Administration in one calendar year.

*Semester
Hours*

Required courses: GB 305; AC 332;
FI 300; MG 301; MK 300; ES 322,
442; IE 473; ES 49227

Approved engineering electives from a
field of specialization10

Note: EC 202 must be selected as a part of the
General Studies requirement. Also, ES 340 and
361 must be selected as a part of the Engineering
Core.

Education. Recent surveys have pointed to an acute shortage of well-qualified high school and junior college teachers of mathematics and the sciences, including engineering science. This pattern is designed to accommodate those who wish to couple an engineering education with a career in teaching. Its content has been organized in cooperation with the College of Education

and the Arizona State Department of Public Instruction. Graduates of this pattern receive a Bachelor of Science in Engineering degree and a secondary teaching certificate with a major in engineering science, and minors in mathematics and physics.

*Semester
Hours*

Required courses: SE 310, 311, 411,
433; EP 310; ES 49222

Approved education elective 3

Approved engineering electives from
a field of specialization12

Note: ES 361 must be selected in the Engineering
Core. PS 310 and 311 must be selected as a
part of the General Studies requirement in social
science.

Pre-Medical. In the past decade the interrelation between engineering and medicine has become vigorous and exciting. It seems certain that our rapidly expanding technology means that engineering will continue to become increasingly involved in all branches of medicine. As this develops, so will the need for physicians trained in the engineering sciences – medical men and women with a knowledge of computer technology, operations research, electronics and cybernetics. In preparation for this new generation, an interdisciplinary pattern has been developed within engineering science whereby a student may satisfy the requirements for entry into medical school while simultaneously fulfilling the requisites for the Bachelor of Science in Engineering degree. This preparation would be of special interest to students whose medical interests lie in research, aerospace and undersea medicine or biophysics.

Since both engineering and medicine have as their goal the well-being of man, this program could be compatible with any field of medical endeavor.

*Semester
Hours*

Required courses: BO 100; CH 118, 120,
317, 318, 417; ZO 100; ES 492 25

Approved engineering electives from
a field of specialization 8

Note: CH 117, 119 and ES 304 and ES 361 or
364 must be selected in the Engineering Core.

Engineering Mechanics and Materials

Engineering Mechanics

The undergraduate engineering mechanics curriculum emphasizes the fundamentals of the engineering sciences and mathematics. Such an education will give the engineer flexibility and understanding in the utilization of new developments and techniques as they arise. Additionally, this background will prepare him for graduate work leading to career opportunities in research and development positions in government and industrial organizations and in teaching and research positions in universities.

The graduate engineering mechanics program offers courses in the broad areas of fluid and solid mechanics. This program also offers advanced courses for engineers in such fields as civil, mechanical, and aeronautics and astronautics who find that their work demands greater depth in understanding fundamental concepts and advanced methods of analysis.

Undergraduate engineering mechanics students may select one of the following elective areas: mechanics, applied mathematics or aerospace. Graduate engineering mechanics students pursue individual programs of study concentrating in such areas as: space mechanics, rotor dynamics, vehicle crashworthiness, structural dynamics, vibra-

tion, acoustics and noise control, wave propagation, elasticity, plasticity, plates and shells, elastic stability, composite materials, experimental mechanics, geophysical fluid mechanics, non-Newtonian fluids, aerodynamics and applied mathematics.

Engineering Mechanics Core

		<i>Semester Hours</i>
ES 346	Methods in Engineering Analysis	(3)
EM 372	Fluid Mechanics	3
EM 415	Vibration Analysis	(3)
EM 422-423	Mechanics of Materials	4
ES 444	Linear Algebra in Engineering	3
EM 492	Projects in Design and Development	(3)

Engineering Mechanics Elective Areas:

Mechanics

Required: EM 413, 424, 425, 450 12
Electives 9

Applied Mathematics

Required: ES 344, 445, 446; MA 470 . . 12
Electives 9

Aerospace

Required: EM 414; ME 427, 450, 465 . 12
Electives 9

Materials Science

The materials science core is designed to provide the student with a strong foundation of basic concepts fundamental to understanding the behavior of a wide range of engineering materials, including semi-conducting

solids, steels and alloy steels, nonferrous alloys, plastics, ceramics and composite materials.

Primary emphasis is placed on mechanical aspects of materials behavior, including laboratory methods of determining properties, and techniques for studying those structural variables and internal reactions which influence properties. Electives available in other areas of materials science include semiconductor materials and devices, materials processing, material-environment interactions and composite materials.

The program provides the student with the background required for employment as a materials engineer in design, research or development. In addition, it serves as well as an undergraduate base for graduate study in any area of materials science.

The graduate program in materials science concentrates on a theoretical approach to crystalline solids, defects and defect interactions, solid state transformations, and advanced experimental techniques for studying the behavior of solids.

Materials Science Core

		<i>Semester Hours</i>
EM 351	Materials Engineering	3
EM 353	Thermodynamics and Kinetics of Solids	3
EM 450	Mechanical Properties of Solids	3
EM 451	X-ray Diffraction and Crystallography	(3)
EM 452	Theory of Solids	3
EM 455	Physical Metallurgy	4
EM 492	Projects in Design and Development	(3)
CH 441	General Physical Chemistry	3
Electives	. . . . .	12

Industrial Engineering

Industrial engineering provides a multi-discipline approach for analyzing, understanding and resolving operational problems within organizations. Emphasis is on objective and analytical procedures for structuring problems to facilitate sound decision making. The IE approach to decision making is to formulate an objective and the constraints imposed on the decision maker and then to evolve decisions that accomplish the objective while meeting the constraints. The method for accomplishing the objective can involve physical theories, management concepts and/or mathematical and computer models.

Modern industrial engineering approaches for designing effective operational systems are universally applicable to all forms of enterprise. Students must gain competence in several areas and be capable of understanding complex systems through the integrated application of knowledge from these areas. The primary areas are computer science, human factors, applied statistics, industrial systems, operations research, organizational control and reliability.

The first degree awarded in industrial engineering is the Master of Science in Engineering degree, which is fully accredited by the Engineers' Council for Professional Development (ECPD). Graduate work also is offered leading to the degrees of Master of Science and Doctor of Philosophy.

At the undergraduate level, industrial engineering course work is offered within the engineering science (ES) curriculum. Specific ES patterns related to industrial engineering are production systems, operations research, computer science, bio-engineering

and pre-professional industrial engineering. The latter pattern is intended for qualified students interested in graduate work in industrial engineering as part of a five-year continuum. Admission does not automatically qualify the student for admission to the fifth-year graduate program, but it is expected that qualified students in this option will complete both the BSE and MSE degrees within a five-year term.

Mechanical Engineering

Mechanical Engineering as a profession is broadly concerned with energy including its transformation from one form to another as well as its transmission and utilization. This includes the conversion of chemical, nuclear or solar energy into mechanical work, the transmission of energy via heat exchangers, pipe lines and mechanical systems and the harnessing of energy to perform useful tasks. Mechanical engineers are employed by every kind of industry to seek new knowledge through research, to do creative design and development and to build and control the modern devices and systems needed by society.

The undergraduate mechanical engineering curriculum includes a core of basic mathematics, physics and engineering science courses common to all branches of engineering. Advanced mechanical engineering courses provide for the analytical study of the fundamental laws governing the use of energy, the principles of design and the principles and use of measurement and control devices. Laboratory experiments illustrate the application of these principles in practical devices. The graduate curriculum emphasizes the research and design aspects

of mechanical engineering. Mechanical engineering students may elect to specialize at all degree levels in one of the elective areas: aerospace, design, measurement systems and controls, nuclear, thermosciences or a general option.

Mechanical Engineering Core

	<i>Semester Hours</i>
EM 422 Mechanics of Materials	2
ME 372 Fluid Mechanics	3
EM 415 Vibration Analysis	3
ME 488 Heat Transfer	(3)
ME 382 Thermodynamics	3
ME 441 Principles of Design	3
ME 445 Preliminary Design	(3)
ME 491 Experimental Mechanical Engineering	3
ME 492 Mechanical Engineering Projects	2
Approved Area Electives	12

Note: ES 346 and 304 must be selected in the Engineering Core.

Mechanical Engineering Elective Areas:

Aerospace. Electives: Students may select a minimum of 12 semester hours from the following courses: ME 427, 450, 451, 453, 455, 471, 487, 493, EM 414.

Design. REQUIRED: ME 321 and 442.
Electives: Students may select a minimum of six additional semester hours from the following courses: ME 331, 332, 427, 465, 487, 493, EM 351, 413, ES 331, 340, 361.

Measurement Systems and Controls.
REQUIRED: ME 465, 462 or 463. (ES 361 must be selected in the Engineering Core.)
Electives: Students may select a minimum of

six additional semester hours from the following courses: ME 451, 462, 463, 487, 493, ES 331, EE 302, 320, 325, 341.

Nuclear. REQUIRED: ME 411. *Electives:* Students may select a minimum of nine additional semester hours from the following courses: ME 412, 413, 415, 465, 487.

Thermosciences. *Electives:* Students may select a minimum of 12 semester hours from the following courses: ME 411, 450, 453, 455, 471, 483, 486, 487, 489, 493.

Pre-approved General. A minimum of 12 semester hours is required. The sequence of courses selected must have continuity and approval of the student's faculty advisor prior to enrollment in any of the selected courses. Normally courses should be selected from the above elective areas, or from 300- and 400-level courses in engineering, the physical sciences or mathematics. At least two of these courses must be 400-level courses.

Engineering Science (Core Courses)

ES 102 Introduction to Engineering. Role of the engineer; elementary engineering problems; current trends in engineering; methods of engineering design; and design project. Lecture, recitation and laboratory. Credit, 2 hours.

104 Engineering Graphics. Graphics as a fundamental means of communication in engineering analysis and design; development of spatial visualization; descriptive geometry, and modern engineering drawing practice. Six hours lecture-laboratory. Credit, 2 hours.

118 Chemical Foundations of Engineering. Atomic and molecular structure, states of matter and their energies, chemical equilibria and reaction rates, organic compounds and

industrial processes. Prerequisite: superior performance in one year of high school physics and chemistry. Lecture, demonstrations and recitation. Credit, 4 hours.

122 Computer Programming. Definition, formulation and flow charting, leading to the solution of complex problems by digital computer, using FORTRAN. Computer made available to students for solution of required projects. Corequisite: MA 120, or prerequisite MA 142. Credit, 2 hours.

200 Engineering Drawing. Lettering, sketching, orthographic projection, sectional views, dimensioning, auxiliary projection, mechanical and structural detailing. Prerequisite: ES 104 or approval of instructor. Six hours laboratory. Credit, 2 hours.

201 Mechanics and Heat. Basic concepts of mechanics and heat with applications to engineering. Lecture, demonstrations and laboratory. Prerequisite: MA 120. Credit, 4 hours.

202 Electrical Science. Basic concepts of electricity and magnetism with applications to engineering. Lecture, demonstrations and laboratory. Prerequisite: ES 201. Corequisite: MA 121. Credit, 4 hours.

203 Engineering Wave Phenomena. Basic concepts of wave phenomena with applications to engineering. Prerequisite: ES 202. Credit, 2 hours.

211 Engineering Mechanics, Statics. Force systems, resultants, equilibrium, distributed forces, friction. First and second moments of areas. Prerequisite: ES 201. Corequisite: ES 345 or MA 212. Credit, 2 hours.

226 Digital Computer Programming. FORTRAN programming and the operation of a stored program digital computer. Prerequisite: MA 117. Lecture and laboratory. Credit, 2 hours.

300 Economic Analysis for Engineers. Economic evaluation of engineering alternatives emphasizing the time value of money. Credit, 2 hours.

304 Atomic and Nuclear Principles. Basic concepts of atomic and nuclear principles with

applications to engineering. Prerequisite: ES 202. Credit, 2 hours.

312 Engineering Mechanics, Dynamics. Kinematics and kinetics of particles, translating and rotating coordinate systems. Rigid body kinematics. Dynamics of systems of particles and rigid bodies. Energy and momentum methods. Prerequisites: ES 211; ES 345 or MA 212. Credit, 3 hours.

313 Mechanics of Materials. Concepts of stress and strain, Hooke's Law; strength and deflection of axial force members, shafts in torsion and beams in flexure; combined stress; stability of columns. Prerequisites: ES 211; ES 345 or MA 212. Lecture, demonstrations and laboratory. Credit, 4 hours.

322 Advanced FORTRAN with Systems Applications. Continuation of ES 103 covering advanced concepts of FORTRAN programming and elementary numerical methods for solving systems engineering problems. Emphasis is on FORTRAN methods of approximation, differentiation, integration, interpolation, extrapolation, algebraic and simultaneous linear equations. Prerequisites: ES 122 or 226; MA 121. Credit, 3 hours.

330 Electrical Networks. Mathematical analysis of networks and linear systems. Corequisites: MA 212 or ES 345. Lecture, demonstrations and laboratory. Credit, 4 hours.

331 Electronic Engineering. Electronic circuits. Prerequisite: ES 330. Lecture, demonstrations and laboratory. Credit, 4 hours.

340 Probability and Statistics for Engineers. Elements of probability and statistics with applications in engineering. Prerequisite: MA 121. Credit, 3 hours.

344 Numerical Analysis in Engineering. Application of numerical procedures to the solution of complex engineering problems. Analysis and organization of practical programs for numerical solution of initial, boundary and eigenvalue problems. Prerequisite: ES 345 or MA 212. Credit, 3 hours.

345 Methods in Engineering Analysis. Line and surface integrals, infinite series; exact and numerical solutions of ordinary differential equations with applications to the problems that frequently appear in engineering. Prerequisite: MA 121. Credit, 5 hours.

346 Methods in Engineering Analysis. Topics from advanced calculus; differentiation and integration of functions of several variables, vector differential and integral calculus. Fourier series and orthogonal functions, infinite series; application to engineering problems. Prerequisite: ES 345 or MA 212. Credit, 3 hours.

348 Applied Mathematical Analysis. Treatment and interpretation of engineering data, mathematical models of engineering problems, linear algebra and introduction to optimization techniques, and computational techniques for solving nonlinear equations. Prerequisite: ES 345 or MA 212. Credit, 3 hours.

350 Structure and Properties of Materials. Basic concepts of material properties with applications to engineering. Corequisite: ES 381. Credit, 3 hours.

361 Measurement Systems Engineering. Application of system design concepts to measurements; static and dynamic measurements. Behavior of transducers, validation of experimental data. Prerequisites: ES 345 or MA 212; ES 313, 330. Lecture, laboratory and recitations. Credit, 4 hours.

364 Chemical Process Instrumentation. Theory and applications of analytical and control instrumentation used in the chemical process industries. Prerequisite: ES 330. Lecture, demonstrations and laboratory. Credit, 3 hours.

371 Fluid Mechanics. Basic principles of continuum fluid mechanics. Prerequisite: ES 381. Lecture, demonstration and laboratory. Credit, 4 hours.

381 Thermodynamics. Work, heat and energy transformations. Relation of properties. Laws, concepts and modes of analysis common to

all applications of thermodynamics in engineering. Corequisite: ES 312. Credit, 3 hours.

400 Engineering Communications. Composition for technical papers, reports and scientific articles suitable for publication. Oral and written presentations. Credit, 3 hours.

402 Technology, Society and Human Values. Examination of values which motivate mankind to create technology. Areas of conflict and resolution between basic human values and technological society. Reading and discussion with visiting discussion leaders. (Also listed under HU 402.) Prerequisite: junior standing or permission of instructor. Credit, 3 hours.

422 Programming Languages. Programming language specification and its application to FORTRAN IV and ALGOL-like languages. Prerequisites: ES 122; ES 345 or MA 212. Credit, 3 hours.

423 Symbolic Programming. Symbolic assembly language programming techniques and applications. Prerequisite: ES 122 or ES 226. Lectures and laboratory. Credit, 3 hours.

424 Introduction to BASIC and COBOL. Introduction to the interactive language BASIC and the business-oriented language COBOL. COBOL emphasis on application to industrial engineering and management information systems. Prerequisites: ES 122 or ES 226. Credit, 3 hours.

425 Advanced Programming. Preparation of FORTRAN programs for research or for work in a broad spectrum of disciplines; influence of computer architecture on the FORTRAN language. Character manipulation and free format, plotting application, data structures; sorting, merging and searching. Magnetic tape and disk operations in FORTRAN. Lectures, projects and laboratory. Prerequisite: ES 122 or ES 226, or approval of instructor. Credit, 3 hours.

441 Probability for Engineers. Theory of transformation in dependent and independent variables, bivariate normal distribution, branching processes, recurrent events, random walks,

Markov chains and simple time dependent stochastic processes. Prerequisite: ES 340. Credit, 3 hours.

442 Engineering Statistics. A continuation of ES 340. Regression correlation, analysis of variance and covariance, randomized block, factorials, Latin Square, incomplete blocks, confounding and fractional replication with applications in engineering. Prerequisite: ES 340. Credit, 3 hours.

443 Matrix Applications. Solution of linear, polynomial and systems of differential equations by methods of matrix algebra and matrix calculus. Applications to networks and waves. Prerequisites: ES 122, 330. Credit, 2 hours.

444 Linear Algebra in Engineering. Matrix theory and numerical analysis of matrix operations. Applications from mechanical, structural, electrical and control fields of engineering. Prerequisite: ES 346 or MA 460. Credit, 3 hours.

445 Complex Analysis in Engineering. Complex variables in engineering; analytic functions, integrals, power series, conformal mapping, application of conformal mapping and transforms to problems in fluid flow, heat transfer and electric potential. Prerequisite: ES 346 or MA 460. Credit, 3 hours.

446 Partial Differential Equations in Engineering. Ordinary differential equations, series solutions, boundary value problems, Fourier series, separation of variables, inhomogeneous problems. Prerequisites: ES 345 or MA 212; ES 346 or MA 460. Credit, 3 hours.

447 Partial Differential Equations in Engineering. Classification of second order partial differential equations; properties of elliptic, hyperbolic, and parabolic equations; generalized Green's identities and functions; integral transforms; variational methods. Prerequisite: ES 446. Credit, 3 hours.

449 Statistical Applications in Chemical Engineering. Descriptive statistics, linear and nonlinear regression analysis, experimental

design, and experimental optimum seeking techniques. Credit, 3 hours.

492 Project in Design and Development. Individual project in creative design and synthesis. Credit, 2 or 3 hours.

Special Graduate Courses: 498, 500, 590, 591, 592, 593, 594, 799 (See pages 46-47.)

Chemical Engineering

Professors:

REISER (EC G-136B), BERMAN, CRAIG

Associate Professors:

DORSON, KUESTER, SATER

KE 211 Chemical Process Calculations. Principles of physics and chemistry applied to the formulation of material and energy balances. Prerequisite: CH 118. Corequisite: MA 121. Credit, 2 hours.

331 Transport Processes. Development and application of the principles of momentum, energy and mass transfer. Corequisite: ES 348. Credit, 4 hours.

332 Chemical Engineering Operations. Process operations including distillation, extraction, absorption, drying, crystallization, filtration, materials handling and preparation. Prerequisite: KE 331. Credit, 4 hours.

333 Transport Phenomena Laboratory. Physicochemical measurements and determination of transport properties. Prerequisite: KE 331. Three hours laboratory. Credit, 1 hour.

342 Applied Chemical Thermodynamics. Energy relations and equilibrium conversions based on chemical potentials and phase equilibria. Credit, 3 hours.

411 Biomedical Engineering. Transport, metabolic and autoregulatory processes in the human body using engineering terminology and analysis, current survey of human system simulation, prosthetic devices, diagnostic

methods, engineering criteria, and properties of biological fluids. Credit, 3 hours.

413 Physiological Instrumentation. Problems, concepts and techniques of biomedical instrumentation in static and dynamic environments; physiological, diagnostic, prosthetic and psychological systems; interdisciplinary communications in bioengineering. Lecture and laboratory assignments. Prerequisite: approval of instructor. Credit, 3 hours.

423 Materials Processing. Phase transformations, crystallography, growth processes, kinetics of solid state transformations; technology of high and low temperatures, vacuum systems, high pressure and clean environments. Prerequisite: ES 381. Credit, 3 hours.

442 Chemical Reactor Design. Application of kinetics to chemical reactor design. Prerequisite: KE 342. Credit, 3 hours.

451, 452 Chemical Engineering Laboratory. Operation, control and design of experimental and industrial process equipment; independent research projects. Corequisite: KE 332. Six hours laboratory. Credit, 2 hours each semester.

461 Process Control. Process dynamics, instrumentation and feedback applied to automatic process control. Prerequisites: MA 212; ES 371. Two lectures, 3 hours laboratory. Credit, 3 hours.

462 Process Design. Application of economic principles to optimize equipment selection and design; development and design of process systems. Prerequisite: KE 332. Credit, 4 hours.

481 Optimization Techniques. Development and application of classical, search and dynamic programming methods for optimizing unconstrained, equality constrained and inequality constrained problems. Credit, 3 hours.

513 Rheology of Fluids. Physical and mathematical foundation of the constitutive fluid equations and their application, including biological fluids, uses and limitations of experimental viscometry, development of multi-

dimensional flow equation for a general fluid. Prerequisite: ES 371. Credit, 3 hours.

515 Physiological Transport Processes. Analysis of heat, mass, momentum and electrical energy transfer in mammals, derivation of both microscopic and macroscopic models based on current research. Credit, 3 hours.

517 Prosthetic and Diagnostic Engineering. Criteria for mechanical replacement or assistance of organ functions and diagnostic methods, equipment and usage; existing methodology and future requirements including detailed designs. Credit, 3 hours.

523 Materials Processing. Solid state theory; control of morphology, purity, growth and defects; formation, structure and properties of thin films; micro-crystals, whiskers, organic crystals. Credit, 3 hours.

524 Surface Phenomena. Structure and thermodynamics of surfaces, grain boundary mobility and migration; friction, adhesion and lubrication; electronic surface properties, interaction of surfaces with gases; corrosion; forms. Credit, 3 hours.

533, 534 Transport Processes. Momentum transfer including turbulent and viscous flow. Newtonian and non-Newtonian fluids, compressible flow, packed and fluidized beds; energy and mass transfer in static and dynamic systems. Prerequisite: KE 332. Credit, 3 hours each semester.

535 Unit Operations. Transport principles applied to modern separation techniques. Credit, 3 hours.

543 Thermodynamics of Chemical Systems. Classical and statistical thermodynamics of nonideal physicochemical systems and processes; prediction of optimum operating conditions. Credit, 3 hours.

544 Chemical Process Kinetics. Reaction rates, thermodynamics, and transport principles applied to the design and operation of chemical reactors. Prerequisite: KE 543. Credit, 3 hours.

562 Chemical Systems Engineering. Process dynamics, systems analysis, computer applications, process control. Credit, 3 hours.

563, 564 Chemical Engineering Design. Computational methods; the design of chemical plants and processes. Credit, 3 hours each semester.

571 Electrochemical Engineering. Principles of electrochemical reactions applied to selected topics such as chemical production, electroplating, electro dialysis, and fuel cells. Prerequisite: CH 418. Credit, 3 hours.

581 Multistage Optimization Principles. Unified theory of optimization including differential, variational and search techniques applied to the design of optimum multistage systems. Credit, 3 hours.

Special Graduate Courses: 498, 500, 591, 592, 593, 594, 692, 799. (See pages 46-47.)

Civil Engineering

Professors:

NEWLIN (EC G-136A), BETZ, HILL, KLOCK, PIAN, SCHOELLER, WILSON

Associate Professors:

LUNDGREN, RUFF

Assistant Professors:

MATTHIAS, O'BANNON, ROSNER

Instructor:

BORGO

CE 241 Surveying. Theory and field work in construction and land surveys. Prerequisite: MA 118. Two lectures, 3 hours laboratory. Credit, 3 hours.

310 Materials for Construction. Structural and behavioral characteristics, engineering properties, measurements and applications of construction materials. Not open to engineering students. Prerequisite: CO 323 or equiv-

alent. One lecture, 3 hours laboratory. Credit, 2 hours.

312 Engineering Materials. Structure and behavior of civil engineering materials. Laboratory investigations and test criteria. Prerequisite: ES 350. One lecture, 3 hours laboratory. Credit, 2 hours.

321 Structural Mechanics. Methods of analysis of structural systems. Truss and beam deflections; influence lines and moving loads; slope-deflection; moment distribution; three moment theorem; introduction to working stress, ultimate strength and plastic design concepts. Prerequisite: ES 313. Three lectures, 2 hours laboratory. Credit, 4 hours.

322 Fundamentals of Structures. Theory of design of steel and reinforced concrete structural elements according to working stress, ultimate strength and plastic design concepts. Prerequisite: CE 321. Three lectures, 3 hours laboratory. Credit, 4 hours.

340 Surveying and Mapping. Large scale mapping of small areas by plane table, transit-stadia and grid squares. Computation of traverses and areas, topographic map reading. Not open to engineering or construction students. Prerequisite: high school or college trigonometry. One lecture, 6 hours laboratory. Credit, 3 hours.

343 Adjustments. Least squares adjustment of geodetic survey data by observation and condition equations using matrices. Problems in weighting observational data. Prerequisite: CE 241. Two lectures, 3 hours laboratory. Credit, 3 hours.

344 Route Surveying. Simple, compound and transition curves; reconnaissance, preliminary and location surveys. Calculation of earthwork. Solar observations for azimuth. Prerequisite: CE 241. Two lectures, 3 hours laboratory. Credit, 3 hours.

361 Environmental Engineering. Man's environment, water resources, hydrologic cycle, chemistry of natural waters, quality requirements and water treatment, water distribution system. Credit, 3 hours.

362 Environmental Engineering. Man's environment, the carbon cycle and biochemistry of wastes, principles of waste treatment, drainage systems. Credit, 2 hours.

371 Selected Urban Problems. Problems of the modern urban environment. Concepts of comprehensive planning. History of urban development, transportation, public service, zoning, land division, urban renewal, neighborhood planning, etc. Credit, 3 hours.

372 Transportation Engineering. Elementary investigation of all forms of transportation: highway, rail, water, air. Similarities and differences in construction, operation, planning and administration. Prerequisite: senior standing. Credit, 3 hours.

380 Hydrology and Hydraulics. Water supply and water distribution, precipitation and runoff, wells. Flow in pressure conduits and open channels. Hydraulic machinery. Not open to engineering students. Credit, 3 hours.

381 Applied Fluid Mechanics. Analysis of fluid-flow concepts and basic equations. Application of fluid mechanics to pressure conduit and free surface flow, unsteady flow and turbomachinery. Laboratory investigations. Prerequisite: ES 371. Credit, 3 hours.

423 Structural Design. Analysis and design of structural systems. Prerequisite: CE 322. Two lectures, 3 hours laboratory. Credit, 3 hours.

431 Theory of Structures. Elastic curvature, real work, virtual work, Castigliano's theorems, consistent deformation, three moment equation, slope deflection, moment distribution, elastic centers and influence lines. Prerequisite: CE 321. Credit, 3 hours.

432 Stress Analysis. Theory of elasticity, unsymmetrical bending, shear center, torsion of noncircular sections; beam columns, curved beams, beams on elastic foundation; contact stresses, stress concentration. Prerequisite: ES 313. Credit, 3 hours.

438 Structural Models. Dimensional analysis and principles of similitude. Direct model analysis, including materials, fabrication,

loading and instrumentation techniques. Indirect models, photoelasticity. Corequisite: CE 431. Credit, 3 hours.

450 Soil Mechanics in Construction. Soil mechanics as applied to the construction field. Application to foundations, highways, retaining walls and slope stability. Relationship between soil characteristics and geologic formations. Prerequisite: senior standing, or approval of instructor. Not open to engineering students. Two lectures, 3 hours laboratory. Credit, 3 hours.

451 Soil Mechanics. Index properties and engineering characteristics of soils. Compaction, shear, compressibility, and permeability. Prerequisites: ES 313, 371. Two lectures, 3 hours laboratory. Credit, 3 hours.

452 Soil Mechanics. Applications of soil mechanics to slope stability, highways, earth dams, foundations, and stress distribution in soil media. Prerequisite: CE 451. Two lectures, 3 hours laboratory. Credit, 3 hours.

453 Site Foundation Engineering. Geological investigations for engineering purposes, case histories, major aspects of geologic structure, weathering, river mechanics, glacial deposits, eolian deposits in the site location for an engineering structure. Prerequisite: GL 301 or approval of instructor. Credit, 3 hours.

461 Environment and Man. Physical, chemical and biological components of the natural environment. Impact of man, origins and types of pollution. Effect of environmental factors on man. Prerequisite: approval of instructor. Credit, 3 hours.

463 Sanitary Chemistry Laboratory. Analyses of water, domestic and industrial wastes, laboratory procedures for control of water and waste treatment processes. Prerequisite: CE 361 or 362. Two lectures, 3 hours laboratory. Credit, 3 hours.

464, 465 Industrial Hygiene. Selected topics including survey methods, legal and physiological aspects of occupational health hazards. Methods of measurement and analysis and

physiological actions of such contaminants as toxic gases, mineral dusts, metals and their compounds, and industrial solvents. Prerequisite: approval of instructor. Two lectures, 3 hours laboratory. Credit, 3 hours each semester.

466 Sanitary Systems Design. Capacity, planning and design of water distribution and domestic and storm drainage systems. Prerequisite: approval of instructor. Credit, 2 hours.

471 City Planning. Municipal organization and administration; public health, public utilities, services, zoning, replanning, critical studies. Prerequisite: approval of instructor. Credit, 3 hours.

473 Engineering Interpretation of Land Forms. North America by geographic regions and the engineering problems and characteristics of each area. Prerequisite: approval of instructor. Credit, 3 hours.

474 Traffic Engineering. Operator and vehicle characteristics, street capacity, signals, signs and markings, etc. All phases of traffic engineering as applied to urban areas. Prerequisite: approval of instructor. Credit, 3 hours.

475 Highway Geometric Design. Design of the visible elements of the roadway. Fundamental design controls with application to rural roads, at-grade intersections, freeways and interchanges. Prerequisites: CE 344, 372. Two lectures, 3 hours laboratory. Credit, 3 hours.

481 Water Resources Engineering. Water resources systems for various types of water utilization, including irrigation, hydroelectric power, navigation and flood control. Physical hydrology. Economic analysis. Case studies. Prerequisite: CE 381. Credit, 3 hours.

482. Free Surface Flow. Steady and unsteady flow in open channels, surface curves, transitions and controls, hydraulic jump, surges and waves. Secondary flows. Prerequisite: CE 381. Credit, 3 hours.

495 Topics in Civil Engineering. Selection and evaluation of the significant variables in civil

engineering problems. Application of concepts acquired in undergraduate curriculum to the development of a rational and feasible problem solution. Prerequisite: senior standing and approval of instructor. Credit, 1 hour.

525 Bridge Design. Computer-aided design of bridges and bridge components. Super-structure design of continuous girder, continuous truss, arch, and suspension bridges. Complete design of a continuous plate girder bridge. Prerequisite: CE 431. Two hours lecture, 2 hours laboratory. Credit, 3 hours.

526 Building Design. Structural design (elastic and plastic) of buildings and frames. Methods of framing, wind and earthquake forces; special systems. Prerequisite: CE 423. Corequisite: CE 431. Credit, 3 hours.

527 Concrete Structures. Elastic, ultimate strength and yield line theory. Deflection, torsion, shrinkage and plastic flow. Prestressed concrete; special systems. Prerequisite: approval of instructor. Credit, 3 hours.

528 Stability of Structures. Elastic and inelastic buckling of rolled and cold-formed columns and beams. Stability of plates, rigid frames and trusses. Prerequisite: approval of instructor. Credit, 3 hours.

529 Aerospace Structures. Analysis and design of aerospace structures and components. Consideration of loads, types of structural systems and system configurations. Prerequisites: CE 432 and 532. Credit, 3 hours.

532 Matrix Methods in Structural Analysis. Matrix methods applied to structural engineering and structural mechanics. Stiffness and flexibility methods, finite elements, finite differences. Prerequisite: CE 431 (or equivalent) and computer programming background. Credit, 3 hours.

533 Optimization of Design. Linear and non-linear mathematical techniques leading to optimum weight and optimum cost design. Application to civil and aerospace structures and civil systems. Prerequisite: approval of instructor. Credit, 3 hours.

534, 535 Plate and Shell Structures. Development of equations and applications of theory to the analysis of plates and shells with emphasis on numerical solutions. Membrane and bending stresses in steel and concrete structures. Prerequisite: approval of instructor. Credit, 3 hours each semester.

536 Dynamics of Structures. Analysis of structures and structural members subjected to dynamic loadings; response spectra theory with emphasis on earthquake applications; investigations of the response of multi-degree of freedom structures; matrix methods of analysis. Prerequisite: approval of instructor. Credit, 3 hours.

553 Theoretical Soil Mechanics. Engineering properties of soils, application of theory of elasticity to soil media, failure theories, theories of consolidation and shear strength of granular materials. Prerequisite: CE 451. Two lectures, 3 hours laboratory. Credit, 3 hours.

554 Theoretical Soil Mechanics. Shear strength of cohesive materials, clay mineralogy and soil structure, theories of bearing capacity, slope stability, compaction, and introduction to soil dynamics. Prerequisite: CE 451. Two lectures, 3 hours laboratory. Credit, 3 hours.

555 Applied Soil Mechanics. Application of theoretical soil mechanics to engineering problems. Earth retaining structures, earth dams, footings, pile foundations, site investigation and sampling techniques. Prerequisite: approval of instructor. Two lectures, 3 hours laboratory. Credit, 3 hours.

556 Seepage and Earth Dams. Transient and steady state flow of water through soil media, confined and unconfined flow, pore water pressures, and application of theories to the design of fluid-control structures. Prerequisite: CE 451. Two lectures, 3 hours laboratory. Credit, 3 hours.

557 Advanced Foundation Engineering. Subsoil investigations, sampling techniques, field measurements, sheeting and bracing, settlement analysis of foundations, equilibrium of

retaining walls and cofferdams. Prerequisite: CE 553. Three lectures. Credit, 3 hours.

561 Theory and Design of Water Treatment Facilities. Theory and design of processes used in the supply and treatment of water. Prerequisite: CE 361 or equivalent. Credit, 3 hours.

562 Theory and Design of Waste Treatment Facilities. Theory and design of waste treatment and disposal systems. Prerequisite: CE 362 or equivalent. Credit, 3 hours.

563 Sanitary Engineering Processes Laboratory. Laboratory study of unit processes involved in water and waste treatment. Prerequisite: approval of instructor. One lecture, 6 hours laboratory. Credit, 3 hours.

564 Industrial Waste Treatment. Types of industrial wastes and effects on the natural environment. Pollution control concepts and regulatory agencies. Waste treatment. Prerequisite: approval of instructor. Credit, 2 hours.

567 Atmospheric Pollution. Atmospheric composition and dynamics, origins and chemistry of contamination, biological significance, analytical measurement, engineering control methods and air pollution legislation. Prerequisite: approval of instructor. Credit, 1-3 hours.

568 Epidemiology and Public Health Engineering. Biology and transmission of diseases, mathematical theory of epidemics, sanitation and public health administration. Prerequisite: approval of instructor. Credit, 1-3 hours.

571 Airport Engineering. Planning and design of airport facilities, financing, air traffic control, aircraft characteristics, demand, site selection, runway configuration and terminal areas. Prerequisite: CE 372. Two lectures, 3 hours laboratory. Credit, 3 hours.

572 Design of Highway and Airport Pavements. Design practices, materials, and testing of flexible and rigid pavements. Prerequisites: CE 372, 451. Two lectures, 3 hours laboratory. Credit, 3 hours.

573 Urban Transportation Planning. Applica-

tion of land use parameters, traffic generation theory, traffic distribution and assignment models, transit analysis and economic factors to the solution of the urban transportation problem. Prerequisite: approval of instructor. Credit, 3 hours.

574 Highway Engineering, Planning and Economics. Highway transportation including design, construction, operation, planning, economic feasibility and financing. Highways as a regional system. Prerequisite: approval of instructor. Credit, 3 hours.

581 Hydrology. Advanced hydrologic principles. Hydrologic measurements, statistical analysis of data; design storms, flood routing; ground water theory. Prerequisite: CE 381. Credit, 2-3 hours.

584 Hydromechanics. Theoretical consideration of water waves, jets, wakes, cavities, stratified flows, diffusion phenomena, unsteady flow in pipes and surge problems, potential flow concepts, and turbulence. Prerequisite: CE 482 or approval of instructor. Credit, 3 hours.

585 Applied Hydromechanics. Advanced topics selected in accordance with student interests; sedimentation phenomena, water waves, coastal processes, flow in porous media, cavitation, density currents, transport phenomena and fluid mixing. Prerequisite: CE 584 or approval of instructor. Credit, 3 hours.

586 Water Resources Systems. Engineering, economic, legal, political, administrative and social factors affecting decisions in resource allocation and water resources systems. Prerequisite: CE 481 or approval of instructor. Credit, 2-3 hours.

587 Water Resources Systems. Water resources project formulation economic analysis, cost allocation, and evaluation of performance. Case studies. Prerequisite: CE 481 or approval of instructor. Credit, 2-3 hours.

588 Hydraulic Design. Analytical and experimental investigation of hydraulic problems.

Prerequisite: approval of instructor. Credit, 1-3 hours.
Special Graduate Courses: 498, 590, 591, 592, 593, 594, 799. (See pages 46-47.)

Electrical Engineering

Professors:

TICE (EC A-209A), BARKSON, DONNELLY,
I. KAUFMAN, KELLY, RUSSELL, SIRKIS,
T. B. THOMPSON, WELCH

Associate Professors:

AX, CLARK, DeMASSA, HIGGINS,
JELSMA, PALAIS, PATTERSON, ROBBINS,
STEINMANN, WOODFILL, ZIMMER

Assistant Professors:

BLACKLEDGE, GELOPULOS, SNIDER

Lecturers:

SAKIOTIS, A. B. THOMSON

EE 302 Electrical Networks. Analysis of networks and linear systems. Prerequisite: ES 330. Credit, 3 hours.

313 Electrical Construction Fundamentals. Electrical circuits and machinery. Elements of power transmission and distribution. Related measurement and instrumentation essentials. Not for EE Majors. Prerequisite: ES 202. Two hours lecture, 3 hours laboratory. Credit, 3 hours.

320 Digital Computer Fundamentals. Design, organization and operation of computer systems. Credit, 3 hours.

325 Analog Methods. Introduction to analog computers. Analog techniques applied to simulation of electrical, mechanical, hydraulic and other dynamic systems. Not for EE students. Prerequisites: ES 345 or MA 212, ES 312, 330. Two lectures, 3 hours laboratory. Credit, 3 hours.

332 Electronic Engineering. Prerequisite: ES 331. Three lectures, 3 hours laboratory. Credit, 4 hours.

341 Electromagnetic Fields. Laplace and Poisson equation, magnetism, Faraday's law, displacement current, Maxwell's equations, electromagnetic waves, radiation, material properties. Prerequisites: ES 202, MA 362. Credit, 3 hours.

357 Semiconductors and Devices. Semiconductors, drift, diffusion, carrier generation and recombination, theory of junctions, diodes, switching, transistors, Ebers-Moll equations. Prerequisites: EE 341, ES 331. Credit, 3 hours.

362 Electromechanics. Magnetic circuits and electromechanical energy conversion; introduction to analog and digital simulation and to machinery laboratory. Prerequisite: EE 302. Three lectures, 3 hours laboratory. Credit, 4 hours.

401 Electrical Networks. Design and analysis of two- and four-terminal passive networks. Traveling electromagnetic waves with application to distributed parameters. Prerequisites: EE 302, 341. Lectures and laboratory. Credit, 4 hours.

402 Network Analysis. Prerequisite: EE 302. Credit, 3 hours.

405 Network Design. Modern network synthesis. Frequency domain approximations. Theory of two-port networks. Prerequisite: EE 302. Credit, 3 hours.

406 Computer-Aided Network Design. Computer methods in AC, DC and transient analysis of linear and nonlinear networks. Selected general purpose programs such as ECAP, CIRCUS and SCEPTRE. Active device modeling. Prerequisite: EE 302. Credit, 3 hours.

420 Digital Systems Design. Switching theory and computer arithmetic, survey of computer circuit technology, introduction to the hardware of a particular computer system. Prerequisite: EE 320 or equivalent. Credit, 3 hours.

421 Digital Systems Design. Investigation of the hardware and software of a particular

digital system. Emphasis on CPU technology and use of on-line assembly and utility systems. Prerequisite: EE 420. Corequisite: EE 427 (except by approval of instructor). Credit, 3 hours.

422 Digital Systems Circuits. Models and analysis of BJT's and FET's in nonlinear electrical circuits for logic, timing, switching, memory and oscillations in digital and analog systems. Prerequisites: EE 320 and ES 331 or approval of instructor. Corequisite: EE 423 (except by approval of instructor). Credit, 3 hours.

423 Digital Circuits Laboratory. Incorporation of digital components into circuits for digital systems applications. Corequisite: EE 422. Three hours. Credit, 1 hour.

425 Analog Computers. Design of basic computing elements, analog computer systems including repetitive and hybrid computers. Scaling and the preparation of practical computer setups with emphasis on nonlinear problems, the use of digital logic in analog computers, special computing techniques. Prerequisites: EE 362, 332. Two lectures, 3 hours laboratory. Credit, 3 hours.

426 System Programming Methods. Programming techniques such as table-look-up procedures, hierarchical data-structures, macro programming and assembler specification. Prerequisite: ES 422. Corequisite: ES 423. Credit, 3 hours.

427 Digital Systems Design Laboratory. On-line operation of a digital system. Corequisite: EE 421. Three hours. Credit, 1 hour.

431 Semiconductor Devices. Nonuniformly doped semiconductors; narrow-base diodes; drift transistors. Base transit time, development of high frequency network models. Basic theory of field effect devices, varactors and PNP structures. Prerequisite: EE 357. Two hours lecture, 3 hours laboratory. Credit, 3 hours.

432 Field-Effect Devices. Surface effects in semiconductors, gradual case and space

charge models for metal-insulator-semiconductor and junction field effect transistors, transit time limitations, small-signal and switching models and applications. Prerequisite: EE 357. Credit, 3 hours.

433 Transistor Circuit Design. Design of typical electronic circuits including amplifiers, mixers, oscillators and power supplies. Prerequisite: EE 332 or equivalent. Three hours lecture, 3 hours laboratory. Credit, 4 hours.

434 Wave Mechanics. Probability, Schrodinger equation, eigenfunctions, harmonic oscillator, hydrogen atom, periodic potential, superposition, angular momentum, scattering, tunnelling, steady state and time dependent perturbation theory. Prerequisites: MA 362; EE 341. Credit, 3 hours.

435 Microelectronics. Study and laboratory practice of solid-state device fabrication techniques including thin film, thick film and integrated circuit fabrication principles. Prerequisites: EE 357 or approval of instructor. Two hours lecture, 3 hours laboratory. Credit, 3 hours.

441 Relativistic Electromagnetics. Approach to the Lorentz force law and Maxwell's equations, using Coulomb's inverse square law and the transformation of special relativity. Prerequisite: EE 341 or equivalent. Credit, 3 hours.

443 Antennas. Theory and application of radiating systems. Prerequisites: EE 341, 401. Credit, 3 hours.

445 Microwaves. Devices and systems. Prerequisites: EE 341, 401. Three lectures, 3 hours laboratory. Credit, 4 hours.

448 Coherent Optics. Devices and systems. Laser applications. Prerequisite: EE 341. Credit, 3 hours.

455 Communication Theory. Spectral analysis of signals and noise. Linear and exponential modulation. Sampling theory and pulse modulation. Comparative analysis of systems. Prerequisites: EE 302, 332. Three lectures, 3 hours laboratory. Credit, 4 hours.

456 Communication Systems. Statistical meth-

ods in communication systems. Representation of random signals. Detection and estimation theory. Prerequisite: EE 455. Credit, 3 hours.

461 Electrical Machinery. Methods and techniques of systems analysis applied to the dynamics of electrical machinery. Prerequisite: EE 362. Credit, 3 hours.

471, 472 Electric Power Systems. Power-system analysis. Prerequisite: EE 362, or approval of instructor. Credit, 3 hours each semester.

480 Feedback Systems. Analysis and design of linear feedback systems. Frequency response and root locus techniques, series compensation and state variable feedback. Prerequisites: EE 332, 362. Three lectures, 3 hours laboratory. Credit, 4 hours.

483 Theory of Systems. Techniques used in the analysis of continuous and discrete linear systems. Not intended for EE graduate students. Prerequisite: EE 302. Credit, 3 hours.

484 Information System Engineering. Individual and group projects with emphasis on physical interactions and limitations on communication, control and information processing system performance, environmental and economic considerations, evaluation criteria, and project organization. Prerequisites: EE 332, 341, 357, 362, and at least one 400-level course. Credit, 3 hours.

490 Electroacoustics. Prerequisite: ES 330; ES 346 or MA 362. Credit, 2 hours.

495 Magnetics. Design of magnetic devices and circuits. Prerequisite: ES 330. Credit, 2 hours.

496 Professional Seminar. Topics of interest to graduating electrical engineers. Open to seniors only. One lecture. Credit, none.

501, 502 Passive Network Synthesis. Synthesis of linear, passive 1-port and 2-port networks. Approximation methods for filters and equalizers. Prerequisites: EE 302; and EE 550 or MA 461 or ES 445 or approval of instructor. Credit, 3 hours each semester.

503 Active Networks. Theory of networks containing general active elements. Linear amplifier design. Prerequisites: EE 302; and EE 550 or MA 461 or ES 445 or approval of instructor. Credit, 3 hours.

504 Active Network Synthesis. Synthesis of active networks for low frequency filtering applications. Use of negative impedance converters, gyrators, and operational amplifiers as active elements. Prerequisite: EE 501, or approval of instructor. Credit, 3 hours.

512, 513 Mathematical Methods in System Engineering. Probability and stochastic processes, operational mathematics, transform methods and state space variables, control theory. Part of graduate integrated system engineering program. Integrates with IE 514, 515. Credit, 3 hours each semester.

516, 517 Logical System Engineering. System design of digital computers, number systems and arithmetic, computer organization. Design and application of serial and parallel logical components including counters, registers, analog to digital converters, adders, subtracters; data structures; system programming; basic hardware and software set. Part of graduate integrated system engineering program. Credit, 3 hours each semester.

518 Digital System Engineering. Design of digital systems hardware and software. Methods and techniques of translating systems requirements into "optimum" hardware designs for a wide range of applications and systems requirements, and systems design of the software component of digital systems including assemblers, interpreters, compilers, monitors and maintenance systems. Part of graduate integrated system engineering program. Credit, 3 hours.

520 Switching Theory. Applications of matrices, partially ordered sets and lattices, to logical design and sequential switching circuits. Prerequisite: EE 320 or approval of instructor. Credit, 3 hours.

521 Digital Systems Hardware. Detailed study of the memory and input-output elements of

a digital computer system. Continuation of EE 421. Prerequisite: EE 421. Credit, 3 hours.

522 Digital Circuit Design. Advanced topics in digital circuit design including tunnel diodes, multi-aperture cores, thin films and integrated circuits. Prerequisite: EE 422. Credit, 3 hours.

523 Control Computers. Process control by means of computers. Prerequisites: EE 421, 480. Credit, 3 hours.

524 Digital Systems Software. Detailed study of the design of computer system software including loaders, assemblers, utility and operating systems. Continuation of EE 421. Prerequisite: EE 421. Credit, 3 hours.

526 Design of Automatic Programming Systems. Methods and techniques of designing compilers for languages such as FORTRAN and ALGOL. Prerequisites: ES 422, 423. Credit, 3 hours.

529 Digital Systems Seminar. Selected topics in theory, design or application. May be repeated for credit. Credit, 3 hours.

531 Semiconductor Device Theory. Junction diodes, junction transistors and field-effect transistors. Includes inhomogeneous impurity profiles, high injection effects, basic fabrication techniques and surface effects leading to the analysis of MOS field-effect transistors. Prerequisite: EE 431 or approval of instructor. Credit, 3 hours.

532 Semiconductor Device Theory. Phenomena including light and heat effects, tunneling, and metal-insulator-semiconductor combinations for devices. Prerequisite: EE 531. Credit, 3 hours.

533 Integrated Circuit Design. Integrated circuit fabrication, device modeling, active and passive parasitics. Comparison of integrated and discrete circuits. Characterization and design of integrated logic and small-signal circuits. Prerequisites: EE 302 and 431, or approval of instructor. Credit, 3 hours.

534 Advanced Topics in Solid State Theory. Electrical and thermal transport properties of

an electron gas. Electron scattering. Thermoelectric devices, electron-phonon interaction, hot electron effects. Acoustic amplification. Excess carrier dynamics. Equilibrium and non-equilibrium processes. Solid state plasma. Photoconductive and photoluminescent devices. Prerequisites: EE 431 and 434, or approval of instructor. Credit, 3 hours.

541, 542 Electromagnetic Fields and Waves. Guided waves, radiation, propagation, reflection and refraction of waves. Prerequisite: EE 341, or approval of instructor. Credit, 3 hours each semester.

543 Antennas. Analysis and synthesis of selected radiating structures and systems. Prerequisite: EE 443 or approval of instructor. Credit, 3 hours.

545 Microwave Solid State Electronics. Material properties, measurements, coupling to circuits, control of transmission, amplification, oscillation, wave propagation, frequency conversion and noise as applied to ferrites, piezoelectrics, microwave diodes and Gunn devices. Prerequisites: EE 357, and 445 or 541; or approval of instructor. Credit, 3 hours.

548 Coherent Optics. Devices and systems. Laser applications. Prerequisite: EE 448. Credit, 3 hours.

549 Lasers. Emission and absorption of radiation, spectra and lifetimes, properties of optical cavities, theory and design of lasers. Prerequisite: EE 434. Credit, 3 hours.

550 Foundations of Linear Analysis and Synthesis. Foundations of linear circuit and system engineering. Fundamental techniques of lumped parameter synthesis. Prerequisite: EE 302. Credit, 3 hours.

552 Error Correcting Codes. Application of the techniques of modern algebra to the analysis of error-correcting and error-detecting codes. Prerequisite: EE 320 or 420. Credit, 3 hours.

554 Random Signal Theory. Application of statistical techniques to the representation and analysis of electrical signals and to communi-

cation systems analysis. Prerequisite: EE 302. Credit, 3 hours.

555 Electrical Communications. Processing of signals in the presence of noise. Random signals, correlation, frequency spectra, estimation, filtering, noise, prediction, transients. Prerequisite: EE 554. Credit, 3 hours.

556 Detection and Estimation Theory. Combination of the classical techniques of statistical inference and the random process characterization of communication, radar and other modern data processing systems. Prerequisites: EE 455, 555. Credit, 3 hours.

557 Information Theory. Definitions of information sources and channels; fundamental theorems of information theory and their significance; simple error-detecting and error-correcting codes. Prerequisite: EE 554. Credit, 3 hours.

558 Modulation Theory. Linear and nonlinear modulation, optimum processors, including the development of performance bounds. Prerequisites: EE 455, 555. Credit, 3 hours.

559 Quantum Theory of Noise. Vectors and operators in Hilbert space; Lie products and the uncertainty principle; statistical density operator, noise in physical systems. Prerequisites: EE 434, 555 or approval of instructor. Credit, 3 hours.

570 Symmetrical Components. Application of symmetrical components to the analysis of power systems and machines. Prerequisites: EE 362, 401 or approval of instructor. Credit, 3 hours.

571 Power System Stability. Transient and steady-state stability limits of power systems. Prerequisites: EE 471 or approval of instructor. Credit, 3 hours.

572 High-Voltage Engineering. Sources, breakdown, measurements and transmission. Prerequisite: EE 471 or approval of instructor. Credit, 3 hours.

574 Unconventional Power Sources. Energy conversion devices and systems other than

conventional rotating machines. Prerequisite: EE 362. Credit, 3 hours.

575 Analysis of Power Networks. Tensor and matrix methods applied to problems involving extensive complex networks. Prerequisite: EE 471 or approval of instructor. Credit, 3 hours.

580 Sampled Data Control Systems. Sampling process, Z-transforms, time and frequency responses, compensation, synthesis of sampled data systems in time and frequency domains. Prerequisites: EE 550, 582. Credit, 3 hours.

581 Random Processes in Control Systems. Random processes in linear systems, state estimation and control system design using Wiener filtering, Kalman filtering, system parameter estimation, combined estimation and control. Prerequisites: EE 550, 554, 582. Credit, 3 hours.

582 State Variables in Control Systems. System representation in state variable form. Lagrangian modeling, calculus of variations in linear optimal control. Prerequisite: EE 480. Credit, 3 hours.

586 Nonlinear Control Systems. Stability theory including phase-plane, describing function, Liapunov's method, frequency domain criteria for nonlinear systems. Relay systems. Prerequisites: EE 550, 582. Credit, 3 hours.

587 Optimal Control Systems. Application of calculus of variations, Pontryagin's principle, and dynamic programming to control problems. Computational techniques for solving optimal control problems. Prerequisites: EE 550, 582. Credit, 3 hours.

588 Automata. Theory of finite state machines, deterministic and probabilistic. Prerequisite: EE 520. Credit, 3 hours.

589 Artificial Intelligence. Progress, problems and prospects of automating cognitive and heuristic reasoning processes. Prerequisite: One 500-level course in computing, or approval of instructor. Credit, 3 hours.

Special Graduate Courses: 498, 590, 591, 592, 593, 594, 799. (See pages 46-47.)

Engineering Mechanics and Materials

Professors:

WALLACE (EC G-120B), ALLEN, AVERY,
L. P. THOMPSON, TURNBOW

Associate Professors:

BICKFORD, NELSON, STANLEY

Assistant Professors:

CHEN, HENDRICKSON, S. J. RUSSELL

Engineering Communications

Professor:

WILCOX

Assistant Professors:

LAWLER, STADMILLER

EM 311 Acoustics of the Environment. Principles of acoustical analysis and design, emphasizing current environmental problems. Prerequisites: MA 141, PH 111. Lecture and demonstrations. Credit, 2 hours.

351 Materials Engineering. Scientific and engineering principles important in the selection and design of engineering materials. Variables influencing material properties and behavior. Prerequisites: CH 114 or ES 118, 202. Two lectures, 3 hours laboratory. Credit, 3 hours.

353 Thermodynamics and Kinetics of Solids. Thermodynamic properties of solutions, rate theory, diffusion in solids, solid state phase transformation, and precipitation phenomena in solids. Prerequisites: ES 350, 381. Credit, 3 hours.

372 Fluid Mechanics. Continuation of gas dynamics, including shock waves, viscous flow analysis and solutions in boundary layer theory, laminar and turbulent flow concepts, similarity considerations. Prerequisite: ES 371. Credit, 3 hours.

411 Acoustics. Principles underlying the generation, transmission, and reception of acoustic waves. Applications to noise control and architectural acoustics. Prerequisites: ES 312, 346 or MA 361. Lecture and demonstrations. Credit, 3 hours.

413 Dynamics. Moving coordinate systems, systems of particles. Euler's equations, gyroscopic motion. Lagrange's equations of motion. Prerequisite: ES 312. Credit, 3 hours.

414 Space Mechanics. Dynamics with applications to aeronautical and astronautical problems, orbits and trajectories, motion in a resisting medium, performance and optimization of multistage rockets. Prerequisite: ES 312. Credit, 3 hours.

415 Vibration Analysis. Undamped and damped vibrations of single-degree-of-freedom systems. Forced vibration, transient response. Many-degrees-of-freedom systems, normal modes, vibration of elastic bodies. Prerequisite: ES 313. Credit, 3 hours.

417 Stability of Motion. Dynamic stability analysis, direct methods of self-excited systems. Applications to: vehicular motion, flutter, wheel shimmy, lateral hunting motion of tracked vehicle, aircraft stability and heave motion of air-cushion vehicle. Prerequisite: ES 312. Credit, 3 hours.

422 Mechanics of Materials. Theories of failure; torsion of noncircular members; thick-walled pressure vessels; curved beams; unsymmetrical bending; shear flow; shear center; circular plates. Prerequisite: ES 313. Credit, 2 hours.

423 Mechanics of Materials. Bending of rectangular plates; membrane theory of shells; energy methods; numerical methods. Prerequisite: EM 422. Credit, 2 hours.

424 Continuum Mechanics. Continuum concepts; stress; deformation and velocity fields; constitutive equations; mechanical properties of solids and fluids; field equations; applications. Prerequisites: ES 313, 371. Credit, 3 hours.

425 Experimental Mechanics. Experimental methods in mechanics; mechanical, electrical and optical transducers; photoelastic and brittle-coating techniques; modeling, correlation and error analyses. Prerequisite: EM 422. Lecture and laboratory. Credit, 3 hours.

450 Mechanical Properties of Solids. Mechanical behavior of engineering materials from the microscopic point of view and the influence of structural defects in determining material properties. Prerequisite: ES 350. Credit, 3 hours.

451 X-ray Diffraction and Crystallography. Fundamentals of diffraction and crystallography. Basic experimental techniques for X-ray diffraction. Fundamentals of X-ray fluorescent spectrometry. Prerequisite: ES 350. Two lectures, 1 hour laboratory. Credit, 3 hours.

452 Theory of Solids. Electronic structure of solids, electrical conduction in metals and semiconductors, dielectric and magnetic properties of solids. Structure sensitive properties and imperfections. Prerequisites: ES 350, 381. Credit, 3 hours.

455 Physical Metallurgy. Solidification; equilibrium transformations; heat treatment of steels; strengthening mechanisms in non-ferrous alloys; mechanical deformation and failure; and annealing phenomena. Prerequisites: ES 350, 381. Three lectures, 1 hour laboratory. Credit, 4 hours.

471 Geophysical Fluid Mechanics. Physical oceanography and dynamic meteorology emphasizing fluid mechanical aspects. Prerequisites: ES 346 and 371. Credit, 3 hours.

492 Projects in Design and Development. Individual and small-group projects, employing design, analysis and development techniques. Credit, 3 hours.

513 Advanced Dynamics. Dynamics of particles, systems of particles. Generalized coordinates, D'Alembert's and Hamilton's principles, Lagrange's equations, kinematics and kinetics of rigid bodies. Prerequisite: ES 346 or MA 460. Credit, 3 hours.

514 Space Vehicle Dynamics. Gyrodynamics and gyroscopic instruments, missile and space vehicle motion, inertial navigation, terminal guidance, flight trajectory optimization. Prerequisite: EM 513. Credit, 3 hours.

515 Dynamics of Elastic Systems. Free vibration and forced response of discrete and continuous systems. Exact and approximate methods of analysis. Prerequisite: EM 415. Credit, 3 hours.

516 Dynamics of Elastic Systems. Continuation of EM 515; random excitation; stress-wave propagation emphasizing transient phenomena. Prerequisite: EM 515. Credit, 3 hours.

517 Nonlinear Vibrations. Qualitative and quantitative methods of analyzing the free and forced response of nonlinear mechanical systems. Prerequisite: approval of instructor. Credit, 3 hours.

522 Variational Principles of Mechanics. Fundamental variational principles: virtual work, minimum and complementary potential energy, Reissner's and Hamilton's principles. Application to the formulation of governing differential equations and boundary conditions. Direct methods of the calculus of variations in treating problems in stability, vibrations, elasticity. Prerequisite: approval of instructor. Credit, 3 hours.

523 Theory of Plates and Shells. Bending of rectangular and circular plates. Plates on elastic foundation. Large deflections of plates. Membrane theory of shells. Bending theory of shells of revolution. Asymptotic integration. Special and approximate methods. Prerequisites: ES 446 or MA 462. Credit, 3 hours.

524 Theory of Elasticity. Analysis of stress and strain in three dimensions, generalized Hooke's law, general theorems. Plane elastostatic problems in rectangular and polar coordinates. Bodies of revolution, general bending and torsional problems and applications. Prerequisite: ES 346 or MA 460. Credit, 3 hours.

527 Theory of Plasticity. Inelastic behavior of metallic and nonmetallic structural materials. Mechanics of perfectly plastic solids and strain-hardening solids. Yield conditions and flow laws. Minimum principles. Credit, 3 hours.

529 Theory of Elastic Stability. General stability concepts; stability of discrete systems, bars, frames, arches and rings. Torsional and lateral buckling. Buckling of thin plates and shells. Dynamic stability. Prerequisite: ES 346 or MA 460. Credit, 3 hours.

530 Continuum Mechanics. Continuum hypotheses. Field laws: mass, momentum, energy, entropy. Constitutive relations. Applications. Credit, 3 hours.

550 Theory of Crystalline Solids. Modern theory of crystalline materials. Crystal structure, mechanical, thermal and transport properties of solids. Band theory and free electron model of solids. Credit, 3 hours.

551 Imperfections in Solids. General properties of lattice imperfections, imperfections in metals and nonmetallic crystals. Prerequisite: EM 550. Credit, 3 hours.

552 Dislocation Theory. Fundamental properties of dislocations in crystals. Dislocation multiplication, motion and interactions. Application of dislocation theory to behavior of solids. Prerequisite: EM 550. Credit, 3 hours.

553 X-ray Diffraction Theory. Properties of X-rays and their interaction with matter, atomic scattering factors. Diffraction of X-rays by crystals, kinematical and dynamical theory, effect of crystal defects. Crystal structure analysis. Experimental techniques. Prerequisite: EM 451. Credit, 3 hours.

571 Fluid Mechanics. Development of basic kinematic, dynamic and thermodynamic equations of the fluid continuum and their application to some basic models. Credit, 3 hours.

572 Mechanics of Inviscid Flow. Fluid motions described by scalar and vector potentials. Compressible and incompressible flow and wave motion. Prerequisites: EM 571; EM 445

or MA 461. Credit, 3 hours.

574 Mechanics of Viscous Flow. Laminar and turbulent flows of viscous fluids. Slow motion, boundary layer flow and free surface flows. Prerequisite: EM 571. Credit, 3 hours.

Special Graduate Courses: 500, 590, 591, 592, 593, 594, 799. (See pages 46-47.)

Industrial Engineering

Professors:

YOUNG (EC G-136C), BEDWORTH, DECKER, HOYT, MIZE

Associate Professors:

LEWIS, SCHAMADAN, SMITH

Assistant Professors:

AUSTIN, MOOR

IE 335 Engineering Law. Influence of contract, property and tort law on engineering activities; contracts, agency, partnerships, corporations, liens and expert testimony. Credit, 3 hours.

411 Engineering Economics. Cash flow model, pricing, economic production charts, economic balance analysis, profitability models. Prerequisite: ES 300. Credit, 3 hours.

421 Human Factors Engineering. Man-machine systems utilizing space program constraints for the development of principles and concepts. Credit, 2 hours.

422 Information Acquisition. Design of systems to collect information for use in managerial decision making, human information processing, methods of information gathering, implementation and evaluation of information systems. Prerequisite: ES 340. Credit, 3 hours.

425 Environmental Bioengineering. The biotechnology of aerospace and undersea environments. Control and utilization of artificial environments. Credit, 3 hours.

431 Engineering Administration. Engineering organization and administration; delegation of authority and responsibility; effective utilization of resources; compensation structure, labor-management relations. Credit, 3 hours.

437 Job Evaluation and Compensation. Analysis and evaluation of work assignments; determination of compensation. Credit, 3 hours.

461 Planning, Scheduling and Control of Resources. Planning, analyzing, controlling and evaluating operating systems, including the application of PERT and CPM methods for project planning. Prerequisite: senior standing. Credit, 3 hours.

462 Design of Industrial Facilities. Planning and layout of industrial facilities. Material flow systems and plant design. Laboratory assignments. Prerequisite: IE 461. Credit, 3 hours.

463 Control Computer Application. Analog and control digital computers in the industrial process. Automation, digital computer logic, assembly language programming, real-time computer operation, computer-interfaced operation. Laboratory assignments. Prerequisite: ES 122 or equivalent. Credit, 3 hours.

473 Foundations of Linear Programming. Application of linear algebra to linear programming. Prerequisite: MA 121. Credit, 3 hours.

474 Acceptance Sampling. Statistical design of sampling plans and procedures for attributes and variables data; operating characteristic curves; federal specifications and standards of quality. Prerequisite: ES 340. Credit, 3 hours.

475 Computing Systems and Techniques. Concepts of digital computers, modes of operation, programming systems and languages. Computing techniques: data structures, searching and sorting, input/output programming, systems limitations. Applications: simulation, information management systems. Prerequisites: ES 122 or 226. Credit, 3 hours.

476 Operations Research Models. Operations research methodology; development of models

and techniques for solving problems such as queueing, inventory and replacement. Prerequisites: ES 340 and MA 212. Credit, 3 hours.

478 Advanced Computing for Industrial and Systems Engineers. Solution of industrial and systems engineering problems using digital computer systems. FORTRAN language emphasized. Devising and using computer library programs in problem areas such as linear programming, matrix operations, network and statistical analysis, system simulation and elementary control systems. (Not open to students having credit in ES 322.) Prerequisites: ES 122 or equivalent; ES 340. Credit, 3 hours.

480 Biosystems. Analysis and explanation of muscular, cardiac, sensory, respiratory and neurological systems as they relate to engineering. Credit, 3 hours.

500 Systems Research Methods. Formalization of the systems approach as related to the field of industrial and systems engineering. Credit, 3 hours.

510 Engineering Economic Analysis. The engineering economic audit, breakeven point analysis, variable budget control of manufacturing costs, cost analysis, and product pricing. Prerequisite: ES 442. Credit, 3 hours.

511 Analysis of Decision Processes. Methods of making economic decisions; statistical decision theory; effects of risk, uncertainty, and strategy on managerial economic decisions. Prerequisite: ES 340. Credit, 3 hours.

514, 515 Analysis of System Operations. Linear programming, inventory models, queueing theory, sequencing, dynamic programming, computational methods. Part of graduate integrated system engineering program. Integrates with EE 512, 513. Credit, 3 hours each semester.

518 Operational System Engineering. Operational analysis and design, system simulation, information acquisition. Methods of making economic decisions; effects of risk, uncertainty and strategy on managerial economic

decisions. Part of graduate integrated system engineering program. Credit, 3 hours.

520 Topics in Human Engineering. Analysis, design and control of human performance in man-machine environments; considerations of physiological and psychological factors as related to system performance. Laboratory assignments. Credit, 3 hours.

521 Applied Synecology. Biological approach to the definition and solution of industrial problems arising from human interactions. Credit, 3 hours.

531 Topics in Engineering Administration. Consideration given to philosophical, psychological, political and social implications of administrative decisions. Credit, 3 hours.

533 Network Analysis. Network analysis techniques, including CPM, PERT, GERT, and maximum flow problems. Prerequisites: ES 441 and IE 473. Credit, 3 hours.

562 Discrete System Control. Application of automatic control methodology to discrete processes. Sampled data systems. Design and synthesis by digital computer; statistical analysis and optimization. Prerequisite: control background or approval of instructor. Credit, 3 hours.

563 Topics in Mechanization and Automation. Analysis of mechanization and automation procedures as applied to selected industrial processes. Specific digital computer installations analyzed and evaluated. Credit, 3 hours.

564 System Optimization Techniques. Methods for determining the maximum and minimum for functions of many variables. Methods include: search procedures, branch and bound techniques, calculus of variations, geometric and dynamic programming. Prerequisite: approval of instructor. Credit, 3 hours.

567 System Simulation with Digital Computers. Application of computer simulation methods to large-scale complex systems using GASP. Review of other simulation programs. Prerequisites: ES 340 and 322, or approval of instructor. Credit, 3 hours.

569 Nonparametric Statistical Inference. Nonparametric problems associated with categorical and noncategorical data. Procedures based on ranks, runs, signs, percentiles; ranking methods in the analysis of variance; Kolmogorov-Smirnov test; tolerance regions. Prerequisites: ES 441 and 442. Credit, 3 hours.

571 Probability for Engineers. Continuation of ES 441. Special topics in advanced probability theory applicable to engineering. Prerequisite: ES 441 or equivalent. Credit, 3 hours.

572 Engineering Statistics. Principles of split plots, transformation of data, nonlinear regression, response surface experimentation and evolutionary operation. Prerequisite: ES 442. Credit, 3 hours.

573 Reliability Models. Probabilistic failure models; measurement, apportionment, estimation and prediction of reliability; life test procedures; redundancy optimization; maintainability and availability. Prerequisite: ES 441 and 442. Credit, 3 hours.

574 Mathematical Programming — Linear. Advanced linear programming. Topics include: simplex techniques, revised simplex technique, duality and the primal-dual technique, and decomposition theory. Prerequisite: IE 473. Credit, 3 hours.

575 Mathematical Programming — Nonlinear. Methods for determining the maximum and minimum for functions of many variables subject to constraints. Methods include: classical calculus, Lagrange multipliers, linear approximations, Kuhn-Tucker conditions, quadratic and integer programming. Prerequisite: IE 574. Credit, 3 hours.

576 Queuing Theory. Analysis of queues using analytical and Monte Carlo methods. Prerequisite: ES 441. Credit, 3 hours.

577 Information Systems Methodology. Systems approach to the analysis, design and implementation of management information systems. Prerequisite: ES 424 or IE 478. Credit, 3 hours.

578 Inventory Theory. Mathematical and sta-

tistical analysis of inventory and warehousing systems. Prerequisites: ES 441 and IE 476. Credit, 3 hours.

579 Time Series Analysis and Forecasting. Analysis of advanced forecasting techniques by time series and probability models, smoothing techniques, auto-correlation and error analysis. Prerequisite: ES 442. Credit, 3 hours.

580 Current Trends in Industrial Engineering. Evaluation of current trends in the theory and practice of industrial engineering. Credit, 3 hours.

Special Graduate Courses: 590, 591, 592, 593, 594, 790, 791, 792, 799. (See pages 46-47.)

Mechanical Engineering

Professors:

RICE (EC G-120D), BEAKLEY, CHILTON, LOGAN, METZGER, PRICE, STAFFORD, STEIN

Associate Professors:

BREGAR, COLLINS, DITSWORTH, EVANS, FLORSCHUETZ, FRY, JANKOWSKI, WOOLDRIDGE

Assistant Professors:

AUTORE, BACKUS, HEDRICK, WOOD

Instructor:

HAWLEY

ME 201 Technology and Social Change. Theories of social change, technology as related to social change, contemporary and possible future impacts of technology on society. Credit, 2 hours.

230 Materials and Industrial Processes. Production techniques and equipment. Conversion of basic materials into consumer products. One lecture, 3 hours laboratory. Credit, 2 hours.

300 Man and Machine. Mechanical invention and technical progress, and the evolution of social forms and institutions. Credit, 2 hours.

301, 302 Science and Technology in History. History of science and technology. Reciprocal relations with the socio-economic processes and institutions. ME 301 is not a prerequisite for ME 302. Credit, 3 hours each semester.

321 Kinematics of Mechanisms. Motions, velocities and accelerations of machine parts, cams, gears, flexible connectors, rolling contact and synthesis of mechanisms. Prerequisite: ES 104. Corequisite: MA 121. Credit, 3 hours.

330 Metallurgy. Metallurgy of iron, steel and nonferrous alloys; atomic and crystal structure; welding, brazing and soldering. For nonengineering majors. Prerequisite: CH 114. Two lectures, 3 hours laboratory. Credit, 3 hours.

331 Principles of Metallurgy. Atomic and microstructure of metals; equilibrium diagrams; metals; cermets and plastics; powder metallurgy; metal joining including electron beam and Laser welding; failure and corrosion; metallurgical analysis and process control. Prerequisite: CH 114 or ES 118. Two lectures, 3 hours laboratory. Credit, 3 hours.

332 Manufacturing Design. Product and process design considerations; coordination of functional design, materials and processes. Two lectures, 3 hours laboratory. Credit, 3 hours.

372 Fluid Mechanics. Application of basic principles of fluid mechanics to problems in viscous and compressible flow. Prerequisite: ES 371. Credit, 3 hours.

380, 381 Applied Thermodynamics. Thermodynamics of engines, turbines and compressors, vapor cycles, gas mixtures, and gas and vapor mixtures. Not open to engineering students. Prerequisites: MA 118; PH 112. Credit, 3 hours each semester.

382 Thermodynamics. Applied thermodynamics; gas mixtures, power cycles and reactive systems. Prerequisite: ES 381. Credit, 3 hours.

401 Theory, Prediction and Social Effects of Invention. Invention as an instrument of

change in civilization; evolutionary nature of inventions, cycle of growth and decline, causation and social effects. Credit, 3 hours.

402 Science in History. Reciprocal relations of science and society from ancient to recent times. Prerequisite: 12 hours credit in science. Credit, 3 hours.

411 Nuclear Engineering. Nuclear chain reactions; nuclear reactor systems and their control; health physics; radiation shielding and applications of nuclear energy. Credit, 3 hours.

412 Nucleonics Laboratory. Laboratory characteristics of nuclear radiations and their interaction with matter; detection and measurement of nuclear radiation. Two lectures, 3 hours laboratory. Credit, 3 hours.

413 Nuclear Reactor Engineering. Nuclear reactor design; reactor control and instrumentation; reactor materials; power reactor economics; power reactor systems; analysis of hazards. Prerequisite: ME 411. Credit, 3 hours.

415 Nuclear System Design. Engineering design of nuclear reactors with emphasis on heat transfer and heat removal. Prerequisite: ME 411. Corequisite: ME 488. Credit, 3 hours.

427 Flight Vehicle Structures. Space structures; thin-walled structures; load factors; non-symmetrical bending and transverse shear; shear center and flow; semi-monocoque construction, fuselage rings; multicelled structures; sandwich panels, fatigue. Prerequisite: EM 422. Credit, 3 hours.

441 Principles of Design. Design procedures; force and motion analysis; failure modes; stress and deflection analysis; stress concentration; fatigue; selected components. Prerequisites: EM 422 and ES 350. Credit, 3 hours.

442 Intermediate Design. Application of the principles and empiricisms of engineering to the creative design of machine components and subsystems. Prerequisite: ME 441. Credit, 3 hours.

445 Preliminary Design. Confrontation of engineering design problems at the professional level; problem formulation and assumptions,

optimization techniques; performance, life and cost. Prerequisite: ME 441. Corequisite: ME 488. One lecture, 2 hours laboratory-lecture, 3 hours laboratory. Credit, 3 hours.

450 Aerodynamics. Vortex theorems, conformal transformation, thin-wing theory, slender-body theory, three-dimensional wings in subsonic and supersonic flow, drag at supersonic speeds. Prerequisite: ME 372. Credit, 3 hours.

451 Automatic Control of Aerospace Vehicles. Static and dynamic stability of aircraft; autopilot design; active and passive control of satellites. Credit, 3 hours.

453 Propulsion. Performance analysis of propulsion systems including turbojet, fanjet and turboprop engines; solid and liquid-fueled rockets; and ion-propulsion devices. Prerequisites: ME 372 and 382. Credit, 3 hours.

455 Turbomachinery. Analysis of flow in turbines and dynamic pumps and compressors; blade losses; design considerations. Prerequisite: ME 382. Credit, 3 hours.

462 Measurement Systems. Continuation of ES 361. Transducer behavior as it affects system characteristics. Signal enhancement and noise suppression. Prerequisites: ES 361, EM 415. Corequisites: ME 488, 491. Two lectures, 3 hours laboratory. Credit, 3 hours.

463 Transducer Physical Principles. Transducers as information and energy processing devices. Characteristics, selection criteria and applications. Prerequisite: ES 361 or ME 565. Corequisite: ME 488. Two lectures, 3 hours laboratory. Credit, 3 hours.

465 Automatic Controls. Theory of control systems including open-loop and closed-loop, with emphasis on mechanical, hydraulic, thermal and pneumatic systems; application of the analog computer to the solution of differential equations. Prerequisite: MA 212. Credit, 3 hours.

471 Numerical Fluid Mechanics. Numerical solutions for selected problems in fluid mechanics. Prerequisite: ME 372. Credit, 3 hours.

483 Internal Combustion Engines. Performance characteristics, combustion, carburetion, cooling, and control of internal combustion engines. Prerequisite: ME 382 or approval of instructor. Credit, 3 hours.

486 Air Conditioning and Refrigeration. Refrigeration cycles, refrigerant properties, heating, cooling loads; psychrometry; purification; temperature and humidity control. Prerequisite: ME 382. Credit, 3 hours.

487 Direct Energy Conversion. Unconventional methods of energy conversion; fuel cells, thermoelectrics, thermionics, photovoltaics, and magnetohydrodynamics. Prerequisites: ES 350, 381. Credit, 3 hours.

488 Heat Transfer. Steady and unsteady heat conduction including numerical solutions; thermal boundary layer concepts and applications to free and forced convection. Thermal radiation concepts. Mass transfer analogies. Corequisite: ME 372. Credit, 3 hours.

489 Statistical Thermodynamics. Statistical approach to thermodynamic concepts, laws and methods of analysis. Generalized p-v-T data. Special systems. Prerequisite: ES 381. Credit, 3 hours.

491 Experimental Mechanical Engineering. Experimental and analytical studies of phenomena and performance of fluid flow, heat transfer, thermodynamics, refrigeration and mechanical power systems. Prerequisites: ME 382, ES 331 or 361. Corequisite: ME 488. One hour lecture, 6 hours laboratory. Credit, 3 hours.

492 Mechanical Engineering Projects. Small group projects in fundamental or applied aspects of mechanical engineering, emphasis on experimental solutions to complex problems. Prerequisites: ME 441, 491. Six hours laboratory. Credit, 2 hours.

493 Experimental System Analysis. Practical approach to a thorough evaluation of an engineering system. Parametric mapping, data acquisition, data analysis and system performance. Prerequisite: ES 361, ME 491. Six

hours laboratory. Credit, 2 hours.

512 Reactor Theory. Neutron moderation; Fermi Age theory; diffusion theory and applications; reflected reactors, multigroup diffusion equations. Prerequisite: ME 411. Credit, 3 hours.

513 Reactor Kinetics and Control. Laplace transform solution of the reactor kinetic equations and reactor transfer functions; reactor stability analysis; nonlinear reactor dynamics. Credit, 3 hours.

514 Reactor Design. Heterogeneous reactor systems, perturbation theory, fuel burn-up, introduction to neutron transport theory. Prerequisite: ME 512. Credit, 3 hours.

515 Radiation Hazards and Shielding. Radiation effects on materials; biological effects of radiation, radiation exposure limits, shielding and detection instruments. Credit, 3 hours.

517 Nuclear Engineering Laboratory. Experiments in nuclear engineering including neutron activation analysis; neutron distribution and dynamics of a sub-critical assembly; simulation of nuclear reactor kinetics using analog computer techniques. Corequisite: ME 413. Two lectures, 3 hours laboratory. Credit, 3 hours.

527 Aeroelasticity. Mutual interaction between aerodynamic and elastic forces and deflection induced in the structures, control mechanisms and propulsion systems of flight vehicles. Prerequisites: ME 427 and EM 415. Credit, 3 hours.

544 Mechanical Design and Failure Analysis. Modes of mechanical failure; dislocation theory; application of principles of elasticity and plasticity in multi-axial state-of-stress to design synthesis; failure theories; fatigue; creep; impact. Prerequisite: ME 445 or approval of instructor. Credit, 3 hours.

545 Mechanical Design and Failure Analysis. Principles, concepts, phenomenological theories, and techniques of analysis associated with failure prevention in mechanical design; emphasis on fatigue, creep, combined

fatigue and creep, and impact. Prerequisite: ME 544. Credit, 3 hours.

548 Kinematic Synthesis and Analysis. Synthesis and analysis of displacements, velocities, and accelerations in mechanical devices. Prerequisite: ME 321. Credit, 3 hours.

549 Advanced Engineering Design Problems. Complex engineering design problems; problem formulation; design of mathematical models; analysis of assumptions; presentation of engineering solution. Problems selected from industrial sources. Prerequisites: ME 544 or approval of instructor. Credit, 3 hours.

551 Aerodynamics. Internal and external gas flows in subsonic through hypersonic regimes; perturbation methods, method of characteristics, similarity rules, three-dimensional wings, optimization of wings and bodies, interference, unsteady flow. Prerequisite: ME 450. Credit, 3 hours.

552 Physical Gas Dynamics. Molecular theories of gases, Boltzmann equation, Chapman-Enskog solution, applications to transport phenomena and low density flows, atomic and molecular structure, elements of statistical thermodynamics, properties of high temperature gases. Prerequisite: approval of instructor. Credit, 3 hours.

553 Mechanics of Reacting Fluids. Molecular and continuum ideas applied to gas dynamics of reacting mixtures; chemical thermodynamics and kinetics, frozen and equilibrium flows, transport properties and flames and detonations. Prerequisite: ME 552 or approval of instructor. Credit, 3 hours.

554 Propulsion. Thermodynamics of aircraft engines; aerothermodynamics of inlets, combustors and nozzles; turbomachinery; performance of rocket vehicles; chemical rockets; nuclear rockets; electric rocket propulsion. Credit, 3 hours.

555 Turbomachinery. Performance characteristics, energy transfer in rotors, cascade mechanics, thin airfoil theory, axisymmetric

potential flow, loss mechanisms, cavitation, surge. Credit, 3 hours.

556 Combustion Systems. Structure, propagation, aerodynamics and stability of premixed and diffusion flames. Effects of forced convection and turbulence. Combustion of solid and liquid fuels and propellants. Designs of burners, furnaces, combustors, rockets. Reactant and product handling systems. Prerequisites: ME 382, 488. Credit, 3 hours.

561 Control System Theory. Nonlinear systems and advanced methods for control system design, including phase plane, describing functions, on-off systems and optimization theory. Prerequisite: ME 465. Credit, 3 hours.

562 Control System Theory. Continuation of ME 561 with emphasis on digital control, stability theory and stochastic control and estimation. Prerequisite: ME 561. Credit, 3 hours.

563 Measurement Engineering Theory. Information processing methods in measuring systems. Effects of energy flow: unbalance, reference balance, and comparison systems. Effects of information flow: DC, sinusoidal and pulse carriers. Noise suppression. Prerequisite: approval of instructor. Two lectures, 3 hours laboratory. Credit, 3 hours.

564 Experimental Stress Analysis. Static and dynamic stresses in models and prototypes. Brittle analogs and coatings, photoelastic analogs and coatings, membrane analogy, electrical analogies, iteration method, strain gages of mechanical and electrical nature. Prerequisites: ES 361 or ME 565. Two lectures, 3 hours laboratory. Credit, 3 hours.

565 Measurement Systems Engineering Theory. Information and energy flow through a system structured of components. Problems in data validation, signal enhancement, noise suppression for analog measurands. Credit, 3 hours.

571 Fluid Mechanics. Basic kinematic, dynamic and thermodynamic equations of the fluid continuum and their application to some basic models. Credit, 3 hours.

572 Fluid Mechanics. Continuation of unified treatment of ME 571 emphasizing compressible and turbulent flows. Prerequisite: ME 571. Credit, 3 hours.

573 Turbulence. Development of Reynolds' and turbulence energy equations. Application to isotropic and anisotropic flow fields. Introduction to research methods and survey of current research activity. Corequisite: ME 574. Credit, 3 hours.

574 Mechanics of Viscous Fluids. Laminar and turbulent viscous flows. Perturbation theory, similarity solutions and numerical solutions for the various flow regimes. Prerequisite: ME 571. Credit, 3 hours.

575 Mechanics of Viscous Fluids. Laminar and turbulent boundary layer flows; other viscous flows having boundary layer characteristics. Prerequisite: ME 574. Credit, 3 hours.

576 Two-Phase Flow and Boiling Heat Transfer. Heat transfer and pressure drop characteristics of two-phase fluid systems; boiling and condensation phenomena; flow and nonflow systems; selected topics. Prerequisite: approval of instructor. Credit, 3 hours.

577 Hydrodynamic Stability. Linear and nonlinear theories of hydrodynamic stability; analytical and numerical solution methods; comparison of theoretical results with experiments. Corequisite: ME 574. Credit, 3 hours.

581 Thermodynamics. Basic concepts, laws and theorems of equilibrium thermodynamics, availability, criteria of equilibrium, applications to compressible, electrostatic, electromagnetic and chemical systems, Credit, 3 hours.

582 Thermodynamics. Statistics of ensembles. Application of thermodynamic concepts and laws to irreversible processes. Prerequisite: ME 581. Credit, 3 hours.

583 Statistical Thermodynamics. Classical and quantum statistics; macroscopic thermodynamic and transport properties; application. Credit, 3 hours.

585 Heat Transfer. Basic equations and con-

cepts of heat transfer; applications to conductive, convective and radiative heat transfer. Prerequisite: ME 488. Credit, 3 hours.

586 Heat Transfer. Continuation of ME 585, emphasizing convection heat transfer. Prerequisite: ME 585. Credit, 3 hours.

587 Heat Transfer. Continuation of ME 585, emphasizing radiation heat transfer. Prerequisite: ME 585. Credit, 3 hours.

588 Thermo-Sciences Laboratory. Experimental techniques in fluid mechanics, heat transfer and thermodynamics. Prerequisite: approval of instructor. Credit, 2-3 hours.

591 Seminar. Credit, 2-3 hours. Topics may be offered in the areas of :

- (a) Thermosciences
- (b) Design
- (c) Measurements
- (d) Nuclear
- (e) Aerospace

594 Graduate Research Conference. Topics in contemporary research. Required every semester of all Mechanical Engineering graduate students registered for 9 or more semester hours. Not for degree credit. Credit, 1 hour.

Special Graduate Courses: 500, 590, 591, 592, 593, 594, 799. (See pages 46-47.)

Division of Agriculture

Richard R. Soderberg, M.S.
DIRECTOR

Purpose. Programs of study in the Division of Agriculture provide the foundation for professional development in four areas of specialization: (1) bio-agricultural sciences, (2) environmental resources in agriculture, (3) agricultural and resource economics, and (4) ag-industry. The first three have a scientific and theoretical program orientation, whereas the fourth is a functional, industry-oriented program. The more traditional study of the life cycle of animals and plants is expanded to include analysis of the effects of environment, either to enhance or inhibit desired production of a particular agricultural organism. Economic, social and political implications are included in the search for improved farm and ranching unit operations. The ag-industry program focuses on the operational functions and management of the broad spectrum of agriculturally related industries (from the supply of resources and services needed by producers of agricultural commodities, to farm and ranch management, the processing and marketing of raw agricultural products, and the management of food and fiber processing plants). The multi-disciplinary curricula integrate the fundamentals of physical, biological and social sciences with mathematics, engineering and business and broaden the student's scope within either: (a) modern, theoretical agricultural science and its inter-relationships with agricultural and environmental resources, or (b) relevant ag-industry. Unique opportunities are available to study the relationship of agriculture to warm, arid

climatic conditions, to the tribal community and to the rural-urban interface.

The Division also provides relevant agricultural courses for those already in ag-industry positions but who have had little or no college level work in agriculture, as well as those enrolled in other colleges and departments who are planning to go into ag-industry positions.

The Division provides special programs for students interested in pre-veterinary medicine, pre-forestry, agricultural education and foreign agricultural service.

The educational and research programs carried out by the Division include aspects of the economic, sociological and political, as well as the physical and biological environments.

Organization. The Division of Agriculture is composed of students, faculty, administrators, staff, and physical facilities including the ASU Field Laboratory. The subject matter is organized in the following manner: (1) bio-agricultural sciences, (2) environmental resources in agriculture, (3) agricultural and resource economics, (4) ag-industry, and (5) special programs. Programs of study involve the areas of specialization described below from which a student is to make selection.

Degrees

BACHELOR OF SCIENCE. A program of a minimum of 126 semester hours of credit, including University General Studies, the Division and area cores and field of emphasis courses, leads to the Bachelor of Science degree. Forty percent of the program of study courses must be upper division.

MASTER OF SCIENCE. Programs leading to the Master of Science degree are offered.

Requirements for these programs are given in the *Graduate Catalog*.

Programs of Study in Agriculture. Programs of study in Agriculture are composed of the General Studies requirement, the Division of Agriculture core requirement, the area of specialization core requirement, together with the field of emphasis courses and elective courses to complete the graduation requirement of 126 credit hours. Prior to entering the junior year, each student, with the aid of an advisor, is expected to select an area of specialization and a field of emphasis.

Division Core Courses. All students earning a Bachelor of Science degree in the Division will complete the following general core courses:

AE 100	Agricultural Economics	3
AE 415	Agricultural Policy	3
AI 374	Food Technology	3
BA 130	Plant Science	3
BA 150	Animal Science	3
BA 352	Nutritional Science	3
EA 232	Soils	3
EA 346	Conservation of Agricultural Resources	3

Areas of Specialization with Fields of Emphasis. Four areas of specialization are provided within which several fields of emphasis are permitted. Each area includes a specified core of courses. In addition, each field of emphasis will include 15 hours of specialized agricultural courses, 15 hours of supporting courses, and enough electives to complete the program. All of these are to be selected in consultation with an advisor.

1. *Bio-Agricultural Sciences*
 - a. Physiology and reproduction
 - b. Nutritional sciences

- c. Animal pathology
- d. Plant science
- 2. *Environmental Resources in Agriculture*
 - a. Soil science
 - b. Renewable resources and the environment
 - c. Bio-agricultural environment
 - d. Environmental horticulture
- 3. *Agricultural and Resource Economics*
 - a. Agricultural economics
 - b. Resource economics
 - c. Rural tribal economics
- 4. *Ag-Industry*
 - a. Agribusiness
 - b. Animal management and production
 - c. Crop management and production
 - d. Food technology

Bio-Agricultural Science. The bio-agricultural sciences area of specialization is concerned with the biological functions and adaptations of domestic animals and plants and their reaction to disease (the pathological state). Also included are the fundamentals of growth, development, nutrition and reproduction functions.

The fields of emphasis in this program are physiology and reproduction, nutritional sciences, animal pathology and plant science. Students selecting a field of emphasis from this program will be required to take the following courses:

BIO-AGRICULTURAL SCIENCE CORE:

- MA 141 Mathematical Analysis I ... 4
- CH 113 General Chemistry 4
- BO 100 General Botany 4
or ZO 100 General Zoology (4)
- CH 231 Elementary Organic
Chemistry 4

- or CH 331, 332 General
Organic Chemistry (6)
- BI 340 General Genetics 3
- CH 361 Elementary Biochemistry .. 3
- AI 381 Plant Propagation 3
or BA 473 Animal
Reproduction (3)
- BA 441 Plant Breeding 3
or BA 456 Animal Breeding (3)
- BA 444 Crop Physiology 3
or BA 457 Animal
Physiology (4)
- BA 453 Physiology of Nutrition 3

Environmental Resources in Agriculture. The study of environmental resources in agriculture consists of a fundamental understanding of factors affecting air, water, soil and other resources associated with plant and animal performance. Fields of emphasis are soil science, renewable resources and the environment, bio-agricultural environment and environmental horticulture. Particular concerns are given toward conservation, range management and controlled environmental systems. Also of concern are urban beautification, pollutants and the ecology of agricultural commodities in a changing environment. Students selecting a field of emphasis from this program will be required to take the following courses:

ENVIRONMENTAL RESOURCES IN AGRICULTURE CORE:

- EA 330 Soil Fertility 3
- EA 338 Range Management 3
- EA 380 Environmental Horticulture . 3
- EA 440 Crop Ecology 3

Agricultural and Resource Economics. Agricultural and resource economics encompass the science of economics as it relates

to the products of agricultural and related natural resources. The economic development and economic foundations of both rural and tribal societies are included.

The fields of emphasis in this academic area are agricultural economics, resources economics, and rural tribal economics. Students selecting this area of specialization program will be required to take the following courses:

AGRICULTURAL AND RESOURCE ECONOMICS CORE:

- AC 101 Elementary Accounting 3
- EC 201 Principles of Economics ... 3
- GB 233 Business Communication .. 3
- GB 305 Business Law 3
- AI 313 Farm Cooperatives 3

Ag-Industry. The ag-industry area of specialization covers the management and operational functions of the broad spectrum of agricultural industries. These include the supply of resources and services needed by producers of agricultural commodities, farm and range management, the processing and marketing of raw agricultural products and the management of food and fiber processing plants. It is designed to give the student academic knowledge regarding food and fiber production and marketing in a form that can be applied to the business and operational aspects of agricultural industries.

Fields of emphasis within the ag-industry area of specialization category include: agribusiness, animal management and production, crop management and production, and food technology.

Students selecting a field of emphasis in ag-industry will be required to take the following courses:

AG-INDUSTRY CORE:

- AE 205 Accounting for Farm Managers 3
or AC 101 Elementary Accounting(3)
- AI 213 Agricultural Marketing 3
- AI 313 Farm Cooperatives 3
- AI 440 Food Manufacturing and Distribution 3
or AI 445 Crop Production and Management(3)
or AI 464 Livestock Production and Management(3)
- AI 443 Agribusiness Management .. 3
or AI 400 Farm and Firm Organization(3)
- BA 353 Applied Animal Nutrition .. 3
or EA 332 Agricultural Chemicals(3)

In addition to the above, EC 201, Principles of Economics, and GB 305, Business Law, are recommended.

Special Programs. Preparatory curricula are offered for students who plan to enter the fields of veterinary medicine, forestry, agricultural education, and foreign agricultural services.

PRE-VETERINARY MEDICINE. The Division of Agriculture offers a three-year pre-veterinary medicine program which will meet, or can be modified to meet, the entrance requirements of professional veterinary medical schools in the United States or Canada. After acceptance into an accredited school of veterinary medicine, four additional years are required to earn the degree of Doctor of Veterinary Medicine. Arizona residents who meet the prescribed state requirements and who are admitted into Washington State University, Colorado State University, or the University of California, Davis, may

attend as Western Interstate Commission for Higher Education (WICHE) exchange students. WICHE funds are available to partially defer educational costs of Arizona students attending one of the above schools.

A pre-veterinary medicine student who elects to earn a Bachelor of Science degree in the Division of Agriculture may do so by taking three years at ASU, completing 94 semester hours of credit, with a minimum of 60 semester hours at ASU, and by completing the agriculture and General Studies requirements. The student may then receive a written statement from the Dean of the College of Engineering Sciences giving senior-in-absentia privileges. The student will be eligible to receive the B.S. degree after the Registrar's Office receives a recommendation from the dean of the professional school and a transcript of credit indicating the student has completed a total of 126 semester hours with a cumulative index of 2.00 or better.

PRE-FORESTRY. Students interested in pre-forestry preparation may enroll in the Division of Agriculture and, in consultation with an advisor, may select courses that meet the specific requirements of the professional school of their choice.

AGRICULTURAL EDUCATION. The first two years of the curriculum preparing students to teach vocational agriculture in the high school is offered as a special program. Students interested in agricultural education may enroll in the Division of Agriculture and, in consultation with an advisor, may select courses to meet requirements of the college from which they plan to obtain their agricultural education degree.

FOREIGN AGRICULTURAL SERVICE. A program of studies is available for students desiring preparation for agricultural work in foreign

industries and developing countries of the world. The objective is to give the student an opportunity to become better acquainted with the physical and cultural environment in which he plans to work. Under the guidance of his advisor, the student may select elective and general studies courses to give a unified area of study concerned with the physical and cultural geography of a region, as well as the government, history, language, religion, philosophy and esthetic values of the people.

Agriculture

Professors:

SODERBERG (Ag. 221), BARRETT, BECKER, JUDD, MILLER, MOODY, PARKER, RICHARDSON, ROBINSON, STILES, TAYSOM

Associate Professors

MONTY, RASMUSSEN

Lecturer:

LYTLE

BIO-AGRICULTURAL SCIENCES

BA 130 Plant Science. Principles of plant growth and development in the rural and urban environment. Two lectures, 3 hours laboratory. Credit, 3 hours.

150 Animal Science. Comparative growth, development and propagation of farm animals. Two lectures, 3 hours laboratory. Credit, 3 hours.

352 Nutritional Science. Energy and nutrients in living systems. Credit, 3 hours.

353 Applied Animal Nutrition. Feedstuffs, feeding standards and their application in meeting nutritional needs of animals producing food and fiber. Prerequisite: BA 352. Credit, 3 hours.

371 Dairy Science. Feeding, breeding and management of animals and facilities for quality milk production. Prerequisites: BA 150. Two lectures, 3 hours laboratory. Credit, 3 hours.

441 Plant Breeding. Principles and methods used in improving farm crops. Prerequisites: BO 100; BI 340. Credit, 3 hours.

444 Crop Physiology. Physiology of crops as influenced by cultural practices and environmental factors. Prerequisite: BO 360. Credit, 3 hours.

453 Physiology of Nutrition. Metabolism of nutrients in the life processes. Prerequisites: BA 353; CH 361 or equivalent. Credit, 3 hours.

454 Ruminant Nutrition. Metabolism of rations and their fermentation products. Prerequisite: BA 453. Credit, 3 hours.

455 Animal Anatomy and Histology. Functional and comparative gross and microscopic anatomy of domestic animals. Three lectures, 3 hours laboratory. Credit, 4 hours.

456 Animal Breeding. Genetics applied to animal breeding. Prerequisites: ZO 100; BI 340. Credit, 3 hours.

457 Animal Physiology. Control and function of the physiological systems of domestic animals. Prerequisites: BA 150; CH 113; ZO 100. Three lectures, 3 hours laboratory. Credit, 4 hours.

458 Diseases of Domestic Animals. Control and prevention of infectious and noninfectious diseases of domestic animals. Prerequisites: BA 457; MI 201. Credit, 3 hours.

460 Endocrinology. Functions of the endocrine glands in the regulation of animal physiological processes. Prerequisite: BA 457 or ZO 360. Credit, 3 hours.

462 Adaptation of Domesticated Animals. Physiological, genetic and behavioral adaptation of domestic animals to their environment. Prerequisite: BA 457 or ZO 360. Credit, 3 hours.

473 Animal Reproduction. Structure and function of the genital system in natural and artificial breeding. Prerequisite: ZO 100. Two lectures, 3 hours laboratory. Credit, 3 hours.

495 Recent Advances in Animal Science. Current developments and literature in animal science. Prerequisite: 10 hours in animal science or equivalent. Credit, 2 hours.

496 Recent Advances in Plant Science. Current literature and recent developments in plant science. Prerequisite: 16 hours in plant science or approval of instructor. Credit, 2 hours.

556 Advanced Animal Breeding. Population genetics in the selection and breeding of farm animals. Prerequisites: BA 456; BI 415. Credit, 3 hours.

ENVIRONMENTAL RESOURCES IN AGRICULTURE

EA 232 Soils. Properties of soils and their relation to plant growth and environmental pollution. Prerequisite: CH 113 or equivalent. Two lectures, 3 hours laboratory. Credit, 3 hours.

330 Soil Fertility. Use of fertilizers, crop rotations and water in the management of soils. Prerequisite: EA 232. Two lectures, 3 hours laboratory. Credit, 3 hours.

332 Agricultural Chemicals. Composition, properties and use of agricultural commercial fertilizers and pesticides and their effects on soil, air and water pollution. Prerequisite: EA 232. Credit, 3 hours.

338 Range Management. Improvement and utilization of range land. Prerequisites: BA 150; BO 100 or approval of instructor. Credit, 3 hours.

340 Weeds and Weed Control. Identification of weeds and methods of control in relation to the environment. Prerequisite: BO 100. Two lectures, 3 hours laboratory. Credit, 3 hours.

346 Conservation of Agricultural Resources. Developing an understanding of the relationships of agricultural resources. Credit, 3 hours.

380 Environmental Horticulture. Plant culture and use in urban agriculture. Prerequisite: BA 130 or permission of instructor. Credit, 3 hours.

438 Advanced Range Management. Specialized problems in scientific range administration and management. Prerequisite: EA 338. Credit, 3 hours.

440 Crop Ecology. Environmental factors affecting the adaptation and distribution of crops. Prerequisite: BA 130. Credit, 3 hours.

446 Soil Conservation. Soil conservation and its relationship to renewable resources. Prerequisite: EA 232. Credit, 3 hours.

448 Soil Classification. Fundamentals of the genesis, morphology and classification of soils; describing soil properties of significance in mapping and interpreting soil survey information. Prerequisite: EA 232. Three lectures, 3 hours laboratory. Credit, 4 hours.

450 Soil Chemistry. Chemical and mineralogical properties of soil colloids; weathering, ion exchange, soil solution reactions, and problems of acid and alkaline soils. Prerequisites: EA 232, CH 225. Three lectures, 3 hours laboratory. Credit, 4 hours.

452 Soil Physics. Physical condition of soils; water relationships, aeration, structure and effects of tillage. Prerequisite: AI 334. Three lectures, 3 hours laboratory. Credit, 4 hours.

463 Hydroponics and Greenhouse Management. Principles and techniques of growing plants in nutrient culture under controlled environmental conditions. Prerequisite: EA 232. Two lectures, 3 hours laboratory. Credit, 3 hours.

466 Soil Microbiology. Nature of soil microorganisms and their biochemical reactions related to soil productivity. Prerequisites: MI 201, 202. Three lectures, 3 hours laboratory. Credit, 4 hours.

AGRICULTURAL AND RESOURCE ECONOMICS

AE 100 Agricultural Economics. Economic aspects of the agricultural industry. Credit, 3 hours.

110 Environmental Safety Economics. Alternate methods, costs and returns of necessary safety measures in agriculture and the environment. Credit, 3 hours.

205 Accounting for Farm Managers. Theory and practice in using accounting in farm management. Use of electronic data processing. Credit, 3 hours.

300 Agrarian Heritage. Evolution of agriculture and impact of man's quest for food and fiber on civilization. Credit, 3 hours.

301 Rural Economics of Tribal Societies. Tribal economic systems and values. Problems of introducing technology and institutional change. Emphasis on Indian tribes of the U.S. and Southwest. Credit, 3 hours.

320 Agricultural Statistics. Application of statistical techniques to agricultural science and economics; computer uses. Credit, 3 hours.

401 Tribal Economic and Community Development. Socio-economic alternatives and options available to tribal people for their development, considering minimizing cultural conflict. Field trips. Credit, 3 hours.

402 Resource Economics. Requirements of society and optimum use of resources; particular attention to agriculture, land, water and rural-urban relations. Credit, 3 hours.

415 Agricultural Policy. Public and institutional interest in agriculture, resulting programs, and their effects. Credit, 3 hours.

459 Food and Fiber Economics. Economics of food and fiber, with implications for the consumer, and consumer implications for the farmer. Credit, 3 hours.

490 Current Topics. Topics in agricultural economics such as current developments in laws,

policies, markets, supply areas, economic theory. Credit, 3 hours.

502 Land Economics. Development of land resources with attention to the rural-urban interface; applications of pertinent methods. Credit, 3 hours.

510 Advanced Agricultural Economics. Principles of economics as evidenced in Arizona agriculture, including vertical integration, bargaining power, and organized labor. Credit, 3 hours.

512 Agricultural Economic Development. Primary role of agriculture in the economic development process. Review of theories; exploration of cause and effect, and agricultural aspects, in economic development. Credit, 3 hours.

AG-INDUSTRY

AI 208 Agricultural Finance. Sources and applications of capital in the agricultural industry. Credit, 3 hours.

213 Agricultural Marketing. An overview of commodity marketing arrangements for producers. Credit, 3 hours.

222 Agricultural Mechanics. Mechanical skills important to agriculture. One lecture, 3 hours laboratory. Credit, 2 hours.

236 Plant Production Practices. Recommended methods and supervised experience in production and harvesting. Prerequisite: BA 130 or approval of instructor. One lecture, 6 hours laboratory. Credit, 3 hours.

253 Animal Production Practices. Supervised farm experience in feeding, breeding and management of general livestock, dairy or poultry. Prerequisite: BA 150 or approval of instructor. One discussion period, 6 hours laboratory. Credit, 2 hours.

262 Equitation. Care, handling and training of horses. One lecture, 3 hours laboratory. Credit, 2 hours.

313 Farm Cooperatives. Organization, operation and management of agricultural cooperatives. Credit, 3 hours.

315 Farm Labor Management. History of concepts and institutional development for labor; legal requirements of employers; labor efficiency methods; personnel management. Credit, 3 hours.

323 Agribusiness Personnel Administration. Recruiting, training and wage administration. Credit, 3 hours.

325 Farm Power and Mechanization. Mechanical solutions to agricultural production problems in the U.S. and abroad, together with selection, evaluation, field operation and servicing of production, harvesting and pest control equipment. Two lectures, 3 hours laboratory. Credit, 3 hours.

333 Agribusiness Purchasing. Working with supplies for agribusiness, including standards, inventories and records. Credit, 3 hours.

334 Irrigation. Water measurement, conveyance and conservation, emphasizing soil-plant water relations and pollution. Prerequisite: EA 232. Credit, 3 hours.

342 Grain Crops. Production, harvesting and utilization of grain crops. Prerequisite: BO 100. Two lectures, 3 hours laboratory. Credit, 3 hours.

344 Alfalfa and Forage Production. Production and storage of forage crops, pasture management and the place of forage crops in rotations and soil conservation. Prerequisite: BO 100. Two lectures, 3 hours laboratory. Credit, 3 hours.

345 Cotton. Production, harvesting and utilization of cotton and its by-products. Prerequisite: BO 100. Two lectures, 3 hours laboratory. Credit, 3 hours.

351 Livestock and Carcass Evaluation. Evaluation of the physical appearance of livestock and carcasses. Two lectures, 3 hours laboratory. Credit, 3 hours.

359 Swine Production. Production, breeding, feeding and management of swine. Prerequisites: BA 150, 353. Credit, 2 hours.

360 Beef Production. Production, breeding, feeding and management of beef cattle. Pre-

requisites: BA 150, 353. Credit, 2 hours.

361 Sheep Production. Production, breeding, feeding and management of sheep. Prerequisites: BA 150, 353. Credit, 2 hours.

362 Horse Production. Production, feeding, breeding and management of horses. Prerequisite: BA 150 or approval of instructor. Credit, 2 hours.

363 Veterinary Practices. Observation of and participation in veterinary medicine and surgery supervised by local veterinarians. Four hours per week with veterinary practitioner plus one hour per week seminar. Open to advanced pre-veterinary students. Prerequisite: approval of instructor. Credit, 2 hours.

364 Ag-Industry Systems. Application of systems analysis to agricultural industries. Credit, 2 hours.

374 Food Technology. Processing and preservation of food products. Two lectures, 3 hours laboratory. Credit, 3 hours.

375 Quality Evaluation of Food Products. Standard methods of measuring quality attributes of raw food products. Prerequisite or corequisite: AI 374. One lecture, 3 hours laboratory. Credit, 2 hours.

381 Plant Propagation. Principles and skills in propagation of plants using seeds, cuttings and grafting. Prerequisite: BO 100. Two lectures, 3 hours laboratory. Credit, 3 hours.

382 Lawns and Greens. Selection, establishment and maintenance of turf grasses for lawn, park and sports areas. One lecture, 3 hours laboratory. Credit, 2 hours.

385 Fruit Production. Production and harvesting of citrus and other tree and vine fruits. Prerequisite: BA 130. Two lectures, 3 hours laboratory. Credit, 3 hours.

387 Commercial Vegetable Crops. Production of truck and processing crops. Mechanical and chemical cultural practices, pest control and harvesting. Prerequisite: BA 130. Two lectures, 3 hours laboratory. Credit, 3 hours.

390 Poultry Industry. Technology of feeding,

breeding and management of birds for production of eggs and meat. Prerequisite: BA 150. Credit, 3 hours.

400 Farm and Firm Organization. Operations-research-planning for farm, ranch or agribusiness firm, using linear programming. Credit, 3 hours.

403 Agribusiness Public Relations. Aspects of the image of agriculture, including consideration of the agricultural press. Credit, 3 hours.

408 Rural Appraisal. Appraisal and valuation of rural assets, especially real estate. Credit, 3 hours.

440 Food Manufacturing and Distribution. Principles of food product formulation, packaging and distribution. Prerequisite: AI 374. Credit, 3 hours.

443 Agribusiness Management. Application of management principles to agriculturally-oriented businesses. Credit, 3 hours.

445 Crop Production and Management. Crop production factors and their application to farm management. Farm plans are prepared for crop production enterprises. Prerequisite: AI 334. Credit, 3 hours.

454 International Agricultural Trade. Dimensions, locations, mix, methods and changes of international trade in agricultural products. Credit, 3 hours.

455 Farm Management. Seminar in management of the farm-firm. Credit, 3 hours.

458 Advanced Agricultural Finance. Case studies and readings, emphasizing the use of capital to increase net profit. Credit, 3 hours.

464 Livestock Production and Management. Methods of production, livestock enterprises, economics, loss prevention and marketing. Prerequisite: BA 353. Credit, 3 hours.

506 Advanced Farm Management. Application of economic theory and operations research techniques to farm-firm operations, including substitution ratios, size effects, time of consideration, tenure and capital management. Credit, 3 hours.

Division of Construction

EDWARD F. SHAFER, JR., M.B.A.,
Director

Purpose

Degree programs in Construction meet a literal revolution in the processes by which man constructs his world. Although the construction industry has long been a leader of the economy in terms of size, growth, complexity and talent employed, education for this diversely technical, entrepreneurial and professional field has been split ineffectively among many agencies until recent years when academicians and constructors, through joint study and analysis, have brought it to operational status as a central and independent discipline.

The advantage of this approach is that construction can be treated as an aggregated management and technical process having economic, social and ecological breadths well beyond basic technical fundamentals. The central purpose remains, as it has since 1957 at Arizona State University, to prepare students directly for positions of functional responsibility and leadership in the field.

Toward these ends instructional programs have developed from fundamental architectural, business, construction and engineering curricula, with the counsel of advisory groups representing leading associations of builders and contractors, to ensure a balanced understanding of the philosophic, technical and professional standards which distinguish modern-day constructors and builders.

Scholarships. Apart from those given by the University generally, a number of scholarships are awarded from the construction

industry on the basis of work done in the construction program.

Work Study and Externship. As an adjunctive part of the program, participating contractors and builders provide summer jobs and offer part-time or work-study arrangements to aid and encourage students to augment classroom theory with practical work experience.

Testing. A construction aptitude test is given to all entering students during the registration period each semester. It is employed for counseling purposes rather than selection.

Special Admission Requirements. Students often wish to enter or transfer in construction from varying backgrounds and undecided high school or college preparatory programs. Deficiencies in mathematics and science, normal at entrance for many, can be covered by adding University credit course work to basic requirements of Construction degree programs. Also, students who do not demonstrate adequate skills in written or speech communications may be required to undertake extra work as individually advised.

Bachelor of Science Degree in Construction

Students seeking a Bachelor of Science Degree in Construction must satisfactorily complete a curriculum of not less than 126 hours, or more where indicated by curriculum option choice or entrance deficiencies.

Construction careers are so broadly diversified that no single curriculum will entirely fit the student for universal entry into all fields. As an example, engineering contractors usually place heavier emphasis on technical and engineering science subjects than do housing industry employers who prefer a

greater depth in management and urban science subjects.

Nevertheless, construction has a common behavioral, management and engineering science core upon which students may build defined option fields to suit individual backgrounds, aptitudes and objectives. These optional fields are not absolute but do match major divisions of the construction industry generally.

OPTIONAL FIELDS:

- Heavy Construction
- Systems Building
- Equipment and Materials Distribution
- Industrial Construction
- Mechanical Construction
- Electrical Construction

(Should the student be undecided as to his career pattern, the Heavy Construction curriculum option is recommended as permitting perhaps the greatest flexibility of later choice).

Each option is arranged to develop management, leadership and competitive qualities in the student and accents requisite technical skills. Prescribed are a combination of: General Studies, a broad range of theoretical and applied management science subjects fundamental to the business side of contracting, and structured technical patterns basic to the execution of engineering and architectural construction work. Not only must the student be educated to survive heavy demands for explicit technical performance during his initial career years – he ought also to understand the functions of his employers and the industry whose agency he serves, and, for the long run, have achieved a pattern of self-growth and learning, which when combined with experience, will qualify

him for positions of eventual administrative judgment and authority.

Bachelor of Science Degree Curricula

General Studies Core: Required of all Construction Students.

Humanities and Fine Arts:

(minimum 8 hours)

*Semester
Hours*

- Architectural History elective 2
- Literature or Philosophy elective 3
- Speech or Theatre performance elective 3

Social and Behavioral Sciences:

(minimum 12 hours)

- EC 201 Principles of Economics 3
- EC 202 Principles of Economics 3
- GB 305 Business Law 3
- Urban Planning elective 3

Science and Mathematics:

(minimum 27 hours or equivalent)

- Chemistry requirement 4
- Computer Science elective 2
- MA 120 Analytic Geometry and Calculus 5
- MA 121 Analytic Geometry and Calculus 5
- ES 201 Mechanics and Heat 4
- ES 202 Electrical Science 4
- QS 221 Quantitative Analysis and Statistics 3

University English Requirement:

(minimum 0-6 hours)

- EN 101 Freshman English 3
- EN 102 Freshman English 3
- (or exemption of one or both by examination. See page 29.)

Hours variable, subtotal shown 53

Construction Core Requirements:

Required of all Construction Students.

	<i>Semester Hours</i>
AC 101 Elementary Accounting	3
ES 102 Engineering Analysis and and Design	2
Engineering Graphics or Architectural Drafting elective	2
CO 174 Construction Systems Management	2
CO 221 Static Mechanics	3
CE 241 Surveying	3
CO 243 Systems Building Design . . .	3
CO 251 Construction Equipment . . .	2
CO 323 Strength of Materials	3
CO 344 Mechanical and Electrical Systems	3
EE 361 Electrical Construction Fundamentals	3
CO 364 Methods Analysis and Design	3
CO 383 Construction Estimating . . .	3
CO 389 Construction Economy and Finance	3
ES 400 Engineering Communications	3
CO 411 Construction Operations Analysis	3
CO 453 Construction Labor Management	2
CO 462 Project Planning and Control	3
CO 482 Cost Engineering	3
CO 496 Contract Administration Seminar	3
Subtotal	55

Construction Field Options: One field to be elected by each student.

HEAVY CONSTRUCTION covers construction contracting for transportation, utility, defense, sanitary and other engineered service systems. Typical projects are roads and highways, railroads, airports, irrigation, and rapid transit systems, harbor and water-front construction, pipelines, dams, tunnels, bridges, canals, sewerage and water works, mass earthwork, missiles launch facilities, and other heavy public works.

Required Courses: AS 306; CE 310, 344, 380, 450; CO 331, 424, 463, 484, Dynamics elective 28

SYSTEMS BUILDING relates to architectural construction and includes commercial and residential building of all types. While conventional building is still a major factor in this field, modern educational focus is on industrialized building systems required for the mass development and production of large scale, turnkey projects and structures. Building construction is treated as a complete administrative process from initial conception through delivery of completed facilities to users.

Required Courses: RE 251, 331, 411; MK 300; CE 310, 380 or 450; CO 331, 424, 463, 471 28

EQUIPMENT AND MATERIALS DISTRIBUTION encompasses broad and varied fields for specifying, advising and inducing engineering sales to the construction industry. Included are customer design applications, delivery, installation, operation and service investigations for: architectural and engineering materials, mechanisms, instruments, components and modular building systems. Of key importance is the solution of ownership, utilization, maintenance and repair problems

related to contractor's plant, equipment and heavy machinery.

Required Courses: MK 300, 434; AS 306; CE 310, 380; Dynamics elective; Construction Engineering or Materials electives 22

INDUSTRIAL CONSTRUCTION describes a complex and important sector of the construction field which undertakes, under a single management authority, the combined design and construction of capital manufacturing facilities for heavy industry, usually erected for the extraction or processing of raw materials. Typical projects are mine and smelter works; refineries and chemical plants; pulp, paper, fiber, and rolling mills; pollution and waste recovery facilities; fossil fuel and nuclear power plants; and many other types of producers' works.

Required Courses: CE 380, 424, 450, 463, Instrumentation, Metallurgy, Dynamics, and Thermodynamics electives . . . 27

MECHANICAL CONSTRUCTION deals essentially with climate and environmental control of buildings including: heating, ventilating, air conditioning, duct work, sanitary and waste piping, and control instrumentation for such facilities. Increasing emphasis is given to systems coordination for more economic building design and construction. Operations often include heavy fabricated piping for industrial plants.

Required Courses: ES 330, 345, 364, 381; 380; CO 485; ME 486, Metallurgy, and Dynamics electives 29

ELECTRICAL CONSTRUCTION deals with the installation and erection of electrical components and systems for the generation, transmission, and distribution of electrical power. Major divisions of this field are: utility plant

and line construction; and interior electrical installations for residential, commercial and industrial projects.

Required Courses: TE 100 or EE 313; TE 230, 360, 440; AS 306; CO 486, and Electrical electives25

Construction

Professor:

SHAIFER (EC A-302)

Associate Professors:

BURTON, MICHELS, PETERMAN, WARD

Assistant Professor:

H. THOMPSON

Lecturer:

S. COHEN

CO 174 Construction Systems Management. Organization and systems theory for construction. Industry functions, processes and economics. Sociotechnical origins and foundations. Elements of leadership and human direction. Juniors and seniors enroll in CO 374. Credit, 2 hours.

221 Static Mechanics. Study of force systems acting on structural members. Centroids, equilibrium, friction, section properties. Prerequisites: ES 201, MA 121. Credit, 3 hours.

243 Systems Building Design. Incorporation of construction materials into building systems. Component specifications and standards. Modulization and modular mathematics. Graphic analysis. Six hours lecture and laboratory. Prerequisite: architectural or engineering drafting. Credit, 3 hours.

251 Construction Equipment. Characteristics, capabilities, limitations and employment of builders' equipment and heavy construction machinery. Automation and control systems. Fleet operations, maintenance programs. Field trips. Credit, 2 hours.

323 Strength of Materials. Analysis of strength and rigidity of structural members in resisting applied forces. Stress, strain, shear, moment deflections, combined stresses, connections. Prerequisite: CO 221 or equivalent. Credit, 3 hours.

331 Construction Safety Engineering. Economics of accident prevention. Hazard analysis. Design for safe field practice. Protective equipment and devices. Occupational diseases. Worker education. Accident procedures. Regulation and insurances. Credit, 2 hours.

344 Mechanical and Electrical Systems. Acoustic, lighting, power, transportation and climate control systems for buildings. Instrumentation. Utility, sanitary, and industrial piping design. Economic integration of structural and environmental systems. Field trips. Six hours lecture and laboratory. Prerequisites: CO 243, EE 313. Credit, 3 hours.

364 Methods Analysis and Design. Engineering and economic analysis of construction work and production systems. Methods design and pre-planning field operations. Crew sizing. Design of materials-handling equipment, rigging and erection gear. Plant organization and layout. Quality control procedures. Field trips. Prerequisites: CO 251, 323, 383. Credit, 3 hours.

374 Construction Systems Management. Similar to and meets with CO 174. Enrollment section for upper class, transfer students only. Freshmen and sophomores enroll in CO 174. Credit, 2 hours.

383 Construction Estimating. Theories and systems of building estimating. Quantity survey techniques, standard formats, classification and analysis of work, organization of detail, unit cost determinations, simulated bids. Prerequisites: AC 101, CO 243, FOR-TRAN. Four hours lecture and laboratory. Credit, 3 hours.

387 Building Construction Estimating. Commercial and residential building construction estimating. Not open to Construction majors. Credit, 3 hours.

389 Construction Economy and Finance. Nature of construction costs. Mathematics of money. Investment models, depreciation and tax theory, variable equipment costs. Cash flow theory, profitability analysis. Funding sources and arrangements. Risk. Builder's insurances. Prerequisite: AC 101 or 332. Credit, 3 hours.

391 Externship. Directed work experience with participating construction firms. Variable credit at 1 hour for each 500 hours of certified paid work. May be repeated for maximum credit of 3 hours.

411 Construction Operations Analysis. Project decision theory. Waiting time models. Risk and contingency evaluation, competitive bidding strategies. Value engineering, cost-benefit analysis, optimization theory. Prerequisites: CO 383, 389. Credit, 3 hours.

424 Structural Design. Economic use of timber, reinforced concrete and steel in building and engineering structures. Foundations. Plastic and ultimate strength design. Prestressed concrete. Student design projects. Prerequisite: CO 323. Credit, 3 hours.

453 Construction Labor Management. Union structure, history, and practice emphasizing building and construction trades. Work customs and project environments. Area productivity differentials. Labor goals, economic power, jurisdictional disputes, grievance procedures. Collective bargaining, government regulation. Credit, 2 hours.

462 Project Planning and Control. Planning and scheduling of resources and operations. Manpower and equipment allocation. Linear programming, network and production diagramming theory, CPM, PERT, cost-time relationships. Program control techniques. Prerequisite: CO 411. Credit, 3 hours.

463 Foundations and Concrete Structures. Subsurface construction theory and practice for foundations of buildings and engineered facilities. Underpinning, piling, dry and wet excavating, de-watering, cofferdams, caissons,

soil stabilization. Concrete form design for foundations and structural frames. Structural erection techniques. Prerequisite: CO 323. Credit, 3 hours.

466 Field Study. Individual or team investigations, photographic chronicling, analysis and report of actual construction field methods. Variable credit, 1 or 2 hours.

471 Industrialized Building. Administrative processes and systems management for urban building and development. Program control techniques. Production, design, marketing, economic and fiscal requirements for mass housing. Consumer needs and trends. Case studies. Credit, 3 hours.

482 Cost Engineering. Functions of the constructor during the research, finance, design and construction phases of complex projects. Computer based cost analysis and conceptual cost estimation. Cost standard synthesis, learning curves, models for pricing and control. Prerequisite: final year standing. Credit, 3 hours.

484 Heavy Construction Estimating. Methods analysis and cost estimation for construction of highways, pipelines, bridges, tunnels, dams and other engineering works. Prerequisites: CE 344; CO 383, or approval of instructor. Four hours lecture and laboratory. Credit, 3 hours.

485 Mechanical Construction. Estimating and construction methods for plumbing, pipefitting, heating and air conditioning in building construction. Credit, 3 hours.

486 Electrical Construction. Individual electrical construction practicum for residential, commercial and industrial projects. Materials, methods and estimating. Prerequisites: CO 383, EE 361, or equivalents. Credit, 3 hours.

496 Contract Administration Seminar. Case studies. Ethical practice, social responsibility, licensing, codes and public regulation of contracting. Quality control requirements. Technical and fiscal failure. Claims, payments and changes. Bonding, insurance, indemnification

procedures. Formulation of management contracts, prime contracts, subcontracts, joint venture and consortium agreements. Arbitration, litigation and specification analysis. Prerequisite: final year standing. Credit, 3 hours.

Division of Technology

WALTER E. BURDETTE, Ed.D.
Director

Purpose

The Division of Technology serves three major functions. One is the preparation of engineering and industrial technologists as members of the total technological team comprised of scientists, engineers, technologists and technicians. A second function is served in the preparation of other specialists who are not properly categorized as technologists, although their preparation is intensively industrially oriented. This function embraces the preparation of such specialists as industrial designers, graphic and printing management personnel, and technical communicators. A third major Division function is the preparation of teachers of industrial and technical education in the elementary and secondary schools, technical institutes, community colleges, universities and in industry.

Each four-year Bachelor of Science degree technology curriculum prepares supporting and specialist personnel in the major areas of research and development, design and manufacturing. While comprehensive and foundational understanding of scientific principles is required, the essential nature of the task to be performed is in translation of the scientific ideas or discoveries into useful products and services. Consequently, these

curricula combine general foundations of scientific theory and facts with laboratory experiences which are designed to instruct in methods rather than to develop extensive skills. Finally, it is the added purpose of these curricula to make the student keenly aware of the urgent problems of society and to develop deeper appreciation of the cultural achievements of man.

The industrial and technical education curricula prepare graduates for positions as industrial arts and technical teachers, department heads, supervisors or directors, consultants and industrial training directors. It is the purpose of the Division of Technology to meet these needs through offerings leading to the completion of the Bachelor of Arts in Education, the Master of Arts in Education, the Master of Science in Technology, the Education Specialist, the Doctor of Philosophy, and the Doctor of Education degrees with specialization in industrial education. (See *Graduate Catalog*.)

The student may select that particular area of specialization which conforms to his interests or his plans. For convenience, the fields of specialization are shown in the following list:

- Aeronautical Technology
- Electronic Technology
- Graphic Communications
- Industrial Design
- Manufacturing Engineering Technology
- Mechanical Engineering Technology
- Industrial Technical Education

Organization

Fields of specialization in Engineering Technology, Industrial Technology and selected specialists programs have been organized

around a core. This core constitutes their base of commonality in communications, economics, electronics, graphics, mathematics and science.

The Industrial Arts Teacher Education program is distinctly differentiated from the above described programs, and its program is therefore organized around its own unique core course experiences.

All programs offered by the Division are organized and presented under the various specializations listed in the preceding section.

Bachelor of Science

These curricula require the satisfactory completion of a minimum of 126 semester hours, which includes General Studies courses, courses of the technology and specialist core, required courses in the field of specialization, supporting field courses and electives. More specific details regarding purposes of these curricula follow in the individual field of specialization materials.

Technology and Specialists Core

	<i>Semester Hours</i>
TE 100 Electricity/Electronics	4
MT 101 Manufacturing Processes and Materials	3
ID 111 Technical Graphics	3
ID 121 Technical Analysis and Design	3
CT 420 Technical Writing	3
PH 111 General Physics	4
CH 113 General Chemistry	4
MA 120 Analytic Geometry and Calculus I	5
or MA 142 Mathematical Analysis II	3

EC 201 Principles of Economics	3
ES 226 Digital Computer Programming	2
	32 or 34 credits

Beyond the requirements of general studies and the appropriate core or cores above, the field of specialization requirements are as follows:

Aeronautical Technology

Instruction combines thorough technical training with a general university education. The curricula are designed to prepare both aeronautical engineering and industrial technologists with theoretical and practical applications in the area of structures, internal combustion, design, management, general and commercial aviation and systems analysis.

Four options are available in this degree program. They are as follows: Option I, Aerospace Technology; Option II, Air Transportation Technology (Flight); Option III, Air Transportation Management Technology (Non-Flight); and Option IV, Aeronautical Engineering Technology.

Each of the four options requires a common Aeronautical Technology Core, in addition to the required Technology and Specialist Core, to insure a sound foundation for the individual areas of specialization.

Aeronautical Technology Core

	<i>Semester Hours</i>
CH 115 General Chemistry	5
PH 112 General Physics	4
ME 380 Applied Thermodynamics . . .	3
MG 301 Principles of Management . . .	3

TA 300 Aircraft Design	3
TA 305 Aircraft and Aerospace Design	3
TA 306 Aircraft Electrical and Electronic Systems	3
TA 308 Combustion Analysis	2
TA 310 Instrumentation	3
TA 384 Airport Planning	2
TA 388 Propulsion	3
TA 390 Systems Analysis	3
TA 487 Aircraft and Aerospace Design	3
TA 488 Airline and Flight Operations Management	3
TA 498 Pro-Seminar	3
	Total credits 46

AEROSPACE

Required Courses: TA 180, 181, 287, 288, 301, 307, 309, and 490; ME 330, 381; MT 116. An additional 5 credits are required in supporting field.

AIR TRANSPORTATION

Required Courses: TA 180, 181, 182, 183, 184, 185, 287, 288, 302, 303, 311, 381, 382, 383, 385, 386, 387, 391, 491, 492 and 493.

AIR TRANSPORTATION MANAGEMENT

Required Courses: TA 180, 181, 287, 288, 303, 391, 491, 493; AC 101, 102; EC 202; FI 300; GB 305; MG 311; and MK 300.

AERONAUTICAL ENGINEERING TECHNOLOGY

Required Courses: ID 310, 311, 340, 360, 112 or ES 104; ME 330, 381; TA 301, 309, 362, 490.

Electronic Technology

A program of electronics is offered to provide men and women an opportunity to prepare for employment in many areas of modern industry. The program of studies includes practical as well as theoretical training in a broad field of electronics. The program allows for a great variety of individual selection. It permits the student to specialize in major electronic areas such as avionics, broadcast communications, computer technology, industrial electronics, instrumentation and control, microwave and optical electronics, telecommunications, television, and others. Electronic Engineering Technology is available to those students primarily interested in activities supporting engineering activities. A student may decide that it is more advisable to use his specialization for a variety of other areas associated with electronics. These are to be selected by the student, and approved by his advisor, for a total of 12 or more hours. Some of these are audiology, aviation, business, chemistry, construction, forestry, manufacturing, mass communications, medical electronics, psychology, technical teaching and technical writing. Any, or all, of the 15 hours of electives in the 126 hours may be used to strengthen or complement a student's selected program.

Students in other curriculum areas may select one or more courses in Electronics to strengthen their particular area of concentration. They may, if they choose, take a minor, consisting of 18 hours in Electronics.

The Electronics core is required as a minimum preparation required of all majors. It is as follows:

Electronic Technology Core

	<i>Semester Hours</i>
TE 101 Applied Electrical Science ..	2
TE 201 Applied Electrical Science ..	2
TE 215 Electro-Mechanical Processes	3
TE 230 Active Devices	3
TE 300 Circuits I	3
TE 301 Circuits II	3
TE 330 Solid State Electronics	3
TE 331 Switching and Wave- shaping Circuits	3
TE 340 Electronic Measurements ..	3
TE 360 Instrumentation Fundamentals	3
TE 4XX (400 Level Electronic Courses)	9
PH 112 Physics	4
IT 160 General Metals	3
Total credits	44

Requirements for completion of the Electronic Engineering Technology option include the courses in the Electronics core as well as the following: TE 341, 400 or 401, 412 or 413, 430 or 431, 440 or 441, 450; TA 309, 362; ID 310 or 311, 340 or 360; ME 380.

Graphic Communications

The graphic communications programs provide a diversified approach for individuals interested in communication techniques. The impact of written and printed business and industrial communications, such as newspapers, magazines, manuals, books, package printing and other visual materials is of great social significance. Visual symbols are

becoming increasingly important in our technological society.

Communications. The Communications program offers students preparation for careers in technical writing, graphics, technical journalism, technical editing and publishing.

Supporting studies in mathematics, science, business, and mass communications provide the student with a varied background of experience to prepare him for growing employment opportunities in technical communications.

Required courses: CT 220, 221, 320, 321, 421; IT 346; GA 135, 136, 438; MG 311; LS 471; EN 313; MC 110, 312. An additional 12 hours are required in a field of technical specialization.

Graphic Arts. This program is designed to provide broad professional education essential for a wide range of careers in the graphic arts industry. Among these are positions in administration and general management, production and quality control, sales and sales management, communications, design, estimating, marketing, advertising, photography and research.

Required courses: GA 135, 136, 236, 237, 238, 333, 334, 336, 337, 339, 435, 436, 438; IT 443; AR 181; MA 141; MG 301. An additional 12 hours are required in a field of specialization.

Industrial Design

The dynamic profession of Industrial Design is concerned with the integration of esthetics, materials, manufacturing, human factors, merchandising and creativity, for the primary purpose of developing solutions to three dimensional problems. Originally associated almost exclusively with product

styling, industrial design has matured to include total planning and development. Products such as the telephone, typewriter, and parking meter, including their associated packaging and graphics and large systems including modular components for industrialized housing or mass transit systems, are now considered legitimate concerns of the industrial designer.

With the growing diversity of Industrial Design interests there has been need to differentiate between central problem solving abilities within the profession. The industrial designer's academic requirements are determined primarily by the nature of the problems he or she will solve professionally. For this reason the Industrial Design program contains two identifiable options in product design and mechanical design to allow for specialized educational development within specific areas of design activity.

Industrial Design Core	<i>Semester Hours</i>
ID 100 Introduction to Design	2
ID 112 Surface Definition	2
ID 160 Sketching Techniques	2
ID 161 Design Illustration	2
ID 200 Descriptive Drawing	3
ID 210 Human Factors in Design	3
ID 215 Materials	3
ID 250 Prototype Construction	2
ID 260 Industrial Design	3
ID 310 Applied Mechanics (Statics)	3
ID 311 Applied Mechanics (Strength of Material)	3
ID 450 Design Integration	3
ID 451 Design Integration	3
Total credits	34

Product Design. Product design embraces most human aspects of machine-made consumer and industrial products. The product designer is generally involved in the entire development process from initial ideation, sketching and modeling; through production, including product planning, advertising and packaging, to the ultimate use of that product. Esthetics and human factors are of primary concern to the product designer how the product he develops relates to and affects human activities—the man/machine/environment relationship.

Required courses: ID 261, 301, 302, 350, 351, 430, 431.

Mechanical Design. The mechanical designer is primarily concerned with the function of the product, its components, and their manufacturing considerations. His prime objective in product development is to develop shape principally from considerations of function, cost, kinematic or structural dictates. In addition, he improves efficiency, reduces costs and prepares layouts, working drawings, and material and operating specifications. He is concerned primarily with how a machine he designs affects, or is affected by, other machines and processes — the machine/machine relationship.

Required courses: ID 201, 303, 305, 306, 307, 340, 360, 406, 407.

Manufacturing Engineering Technology

Increased technological complexity and sophistication has created great industrial demand for the services of those individuals who possess working knowledge of the technical phases of production. Manufacturing engineering technologists perform a vital function in the follow through and com-

pletion of engineering decisions and the solving of manufacturing problems. Accordingly, this curriculum is intended to prepare students to meet the responsibilities in planning the processes of production, developing the tools and machines, and integrating the facilities of production or manufacturing. Two fields of specialization are included in Manufacturing Engineering Technology: machine tool operations and welding operations.

Manufacturing Engineering Technology Core

	<i>Semester Hours</i>
MT 200 Manufacturing Processes	3
MT 201 Manufacturing Processes	3
MT 400 Numerical Control	2
MT 401 Metrology and Quality Control	3
MT 402 New Production Processes	3
ME 330 Metallurgy	3
ME 380 Thermodynamics	3
PH 112 General Physics	4
ID 310 Applied Mechanics (Statics)	3
ID 311 Applied Mechanics (Strength of Materials)	3
ID 340 Fluid Mechanics	3
ID 360 Applied Dynamics	3
TE 101 Applied Electrical Science	2
TA 362 Engineering Technology Mathematics	5
Total credits	43

Machine Tool Operations. The option of Machine Tool Operations is designed to prepare manufacturing engineering technologists with both conceptual and practical

applications of processes, materials, and products related to metalworking industries. Emphasis will also be focused on the management and supervisory roles of personnel in the highly automated manufacturing systems.

Required courses: MT 300, 301, 302, 303, 304, 403, 404; ID 370.

Welding Operations. The option in Welding Operations within Manufacturing Engineering Technology is designed to meet the needs of industry for those individuals trained specifically as technologists, supervisors, or consultants in welding and related fields. This specialization offers opportunities for students to gain both conceptual and practical knowledge of the techniques and applications of the principal welding processes and materials. Emphasis will also be focused on applied weldment design, metallurgy, weld analysis and testing as related to current techniques used by manufacturing industries.

Required courses: MT 110, 111, 210, 310, 311, 410, 411, 412.

Mechanical Engineering Technology

The Mechanical Engineering Technologist is concerned with applications within the broad and diversified field of Mechanical Engineering. Among the responsibilities which may be assigned to such technologists are development and evaluation of machines, power generation, transmission, instrumentation and testing. He may be required to lay out, develop details or supervise the development of a machine or process. In addition, he may test, evaluate performance and make such alterations as to make that machine or process operable and competitive.

The following core is intended to provide

a broad, fundamental base in technical science and skill development in mechanical technology at the baccalaureate level.

Mechanical Engineering Technology Core

	<i>Semester Hours</i>
ID 112 Surface Definition	2
ID 200 Descriptive Drawing	3
ID 201 Descriptive Drawing	2
ID 306 Mechanical Design	4
ID 307 Mechanical Design	4
ID 310 Applied Mechanics (Statics)	3
ID 311 Applied Mechanics (Strength of Materials)	3
ID 340 Fluid Mechanics	3
ID 360 Applied Dynamics	3
MT 201 Manufacturing Processes	3
MT 404 Materials Analysis and Testing	3
ME 330 Metallurgy	3
ME 380 Thermodynamics	3
PH 112 General Physics	4
TE 101 Applied Electrical Science	2
TA 362 Engineering Technology Math	5
Total credits	50

In addition to the above, a student may select, with advisor approval, additional coursework within such subject areas as power and propulsion, applied design or instrumentation.

Industrial Technical Education

Combining courses in technology, general studies and professional education, students

may prepare for educational careers in industrial arts, technical teacher education and industrial training and supervision. Specialization in a variety of technical areas is possible.

Industrial Arts Education. The specific objective of this program is to prepare students for the requirements of industrial arts teaching. The carefully planned pattern of course work permits students to receive a balance and sequence of study. The curriculum leads to a Bachelor of Arts in Education and certification for teaching. For the specific requirements of general and professional education, consult the College of Education section.

There are two options available for industrial arts education majors: (1) an extended major of 60 hours, and (2) a 36-42 hour major with a 24-hour minor. Minors available include: drafting, electronics, graphic arts, metals, transportation and power and woods. An industrial arts minor of 24 hours is available to majors from other departments.

Required courses: ID 111; GA 135; TE 100; IT 121, 160, 170, 204, 346, 402, 480.

An additional 6 hours of professional electives and 29 hours are required in specialization or supporting fields.

Technical Teacher Education. The purpose of this program is to develop competency in one of the technologies and in professional industrial technical education. This four-year Bachelor of Science degree technology curriculum prepares personnel for teaching positions in technology programs offered in higher education institutions:

Required courses: IT 401, 402, 443, 446, 480, 491, 498; EP 422; PX 100. A minimum of 40 credits, approved by the advisor, is required in a specialization or

supporting field, of which IT 445, Industrial Internship, may be a part.

Industrial Training and Supervision. The purpose of this program is to prepare instructors, training directors, and supervisors for industry. Leading to a Bachelor of Science degree, this program provides for a general education background with specialization in industrial technical training and supervisory studies.

Required courses: IT 401, 402, 443, 444, 480, 491; EP 422; PX 100. A minimum of 40 credits, approved by the advisor, is required in a specialization such as business, engineering or technology.

Technology

Professors:

BURDETTE (TC 201), BARTEL, BROWN,
KIGIN, LITTRELL, THOMASON

Associate Professors:

BENZINGER, KANNEMAN, PRUST

Assistant Professors:

ADAMS, BAMFORD, BURK, CAVALLIERE,
EDWARDS, HIGBEE, KEITH, NIELSEN,
PARDINI, ROOK

Instructor:

BAGLEY

Lecturers:

ANDERSON, HAY, MINTER, REED, ROPER,
RUITER, SCHOEN, SPERSTAD

Bachelor of Science Degree (Technical Fields of Specialization)

The Division of Technology offers fields of specialization in Aeronautical Technology, Electronic Technology, Graphic Communica-

tions, Industrial Design, Manufacturing Engineering Technology, Mechanical Engineering Technology, and Industrial Technical Education.

Bachelor of Arts in Education Degree Curriculum (Fields of Specialization)

Students majoring in Industrial Arts Education may specialize in one of the following areas: transportation and power, drafting, electronics, graphic arts, metals, woods, and general industrial arts.

Departmental Graduate Programs

The Division of Technology offers programs leading to the degree Master of Science in Technology. In addition, the department participates in: (1) the Master of Arts in Education degree program as a subject matter field in Secondary Education, (2) the Education Specialist degree program as a major teaching field, and (3) the Doctor of Education degree program with a major in Industrial Education. Consult the *Graduate Catalog* for requirements.

AERONAUTICAL TECHNOLOGY

(Flight instruction costs are not included in University tuition.)

TA 180 Aircraft and Aerospace Structures. Design considerations, aerodynamic fundamentals, construction, manufacturing techniques and processes. Two lectures, 4 hours laboratory. Credit, 3 hours.

181 Aircraft and Aerospace Systems. Modern aircraft and space systems, hydraulics, pneumatics, instrument systems, control systems, weight and balance, and inspection methods. Prerequisites: TA 180. Two lectures, 4 hours laboratory. Credit, 3 hours.

182 Basic Ground School. Principles of flight, aircraft maintenance and pre-flight procedures, navigation under visual flight rules, radio procedures, and FAA regulations for glider pilots and private pilots. Credit, 3 hours.

183 Glider Pilot Rating. Flight training for the Glider Pilot Rating. Satisfactory completion of FAA tests is required. Prerequisite: TA 182; corequisite: TA 184. Credit, 1 hour.

184 Intermediate Ground School. Physiology of flight, aviation meteorology, radio navigation, FAA regulations for commercial and instrument pilots. Prerequisite: TA 182. Credit, 3 hours.

185 Private Pilot Certificate. Flight training for the FAA Private Pilot Certificate. Satisfactory completion of FAA tests is required. Prerequisite: TA 183; corequisite: TA 184. Credit, 1 hour.

287 Aircraft and Aerospace Powerplants. Theory of internal combustion engines, components, power curves, gas turbines, thrust, inspection and processes. Two lectures, 4 hours laboratory. Credit, 3 hours.

288 Aircraft and Aerospace Powerplant Systems. Theory and design, operation, inspection, engine installations, turbomachinery, analysis of engine systems and accessories. Prerequisite: TA 287. Two lectures, 4 hours laboratory. Credit, 3 hours.

300 Aircraft Design. Considerations, theory and concepts, airfoil and wing theory, performance analysis, correlation of design requirements with manufacturing practice. Prerequisites: TA 181, 288, MA 120 or 142, ME 380, PH 111. Credit, 3 hours.

301 Applied Aerodynamics. Properties of air, airfoil theory, methods in aerodynamic testing, and wind tunnel model development. Prerequisite: TA 300. Two lectures, 3 hours laboratory. Credit, 3 hours.

302 Meteorology. Atmospheric phenomena, nephology, low and high altitude weather, weather interpretation, analysis, evaluation

and safety considerations. Prerequisite: PH 111. Credit, 3 hours.

303 Aviation Regulations. System definition, implementation, legislative and administrative rule-making procedures, concept of sovereignty, statutory provisions and resulting regulations, enforcement methods, and definition of terms. Aircraft and airmen certification requirements. Credit, 2 hours.

305 Aircraft and Aerospace Design. Vector analysis and topics in structural analysis as applied to aircraft and aerospace vehicles. Prerequisites: MA 120 or 142, PH 112. Credit, 2 hours.

306 Aerospace Electrical and Electronic Systems. Theory, design, reliability requirements, applications of complex electrical and electronics systems, communications and navigation equipment used in aircraft and aerospace vehicles. Prerequisites: TE 100, MA 120 or 142, PH 112. Credit, 3 hours.

307 Aerospace Systems Design. Analysis and design of aircraft and spacecraft systems, performance evaluation for rockets and missiles. Prerequisite: PH 112. Credit, 3 hours.

308 Combustion Analysis. Principles of combustion systems, components, chemical and physical performance analysis of fuels and lubricants using standard ASTM Testing Methods. Prerequisites: TA 288, MA 120 or 142, ME 380, PH 112, CH 114. Credit, 2 hours.

309 Quality Assurance and Inspection Methods. Purpose of inspection, expressive quality standards, sampling methods, equipment use, material testing and processes. Credit, 2 hours.

310 Instrumentation. Application of instrumentation and measurement to aerospace systems. Concepts of motion mechanics through instrument theory and practical application. Prerequisite: TA 306. Two lectures, 3 hours laboratory. Credit, 3 hours.

311 Air Traffic Control. History and development of procedures involved in control of airborne traffic during VFR and IFR conditions.

Governing regulations and safety requirements. Credit, 2 hours.

362 Engineering Technology Mathematics. Solution of polynomials by numerical methods; linear algebra, differential and integral calculus; infinite and trigonometric series; ordinary differential equations as related to engineering technology; basic methods and concepts in probability and statistics. Prerequisite: MA 142 or 120. Credit, 5 hours.

381 Advanced Ground School. Topics for advanced pilots. Instrument flying techniques and procedures, long range cruise control, emergency first aid and survival methods. Prerequisite: TA 184. Credit, 3 hours.

382 Air Navigation. Advanced navigation methods and underlying principles. Pressure pattern, celestial, and grid navigation, integrated navigational systems, space navigation, and commercial operational concepts of navigation systems. Prerequisite: TA 184. Credit, 2 hours.

383 Instrument Pilot Rating. Flight training for the FAA Instrument Pilot Rating. Satisfactory completion of FAA tests is required. Prerequisite or corequisite: TA 385. Credit, 1 hour.

384 Airport Planning. Community and airport relationships, site selection, financing, navigation aids, geometric design of airport, terminal buildings, lighting and planning considerations. Credit, 2 hours.

385 Commercial Pilot Certificate. Flight training for the FAA Commercial Pilot Certificate. Satisfactory completion of FAA tests is required. Prerequisite: TA 185; corequisite: TA 381. Credit, 2 hours.

386 Flight Instructor Rating. Prepares the commercial pilot for an FAA Flight Instructor Certificate. Satisfactory completion of FAA tests is required. Prerequisite: TA 385 or approval of instructor. Credit, 2 hours.

387 Multi-Engine Rating. Prepares the commercial pilot for an FAA Multi-Engine Rating. Satisfactory completion of FAA tests is

required. Prerequisite: TA 385 or approval of instructor. Credit, 1 hour.

388 Propulsion. Principles, thrust, performance, combustion systems metallurgy, gas turbines, ram jets, rockets, and combustor design considerations. Prerequisite: TA 308. Two lectures, 3 hours laboratory. Credit, 3 hours.

390 Aerospace Systems Analysis. Theory, research and development methods, parameters, analysis of product flow, planning control, methods, total system concept, organization, development and evaluation. Prerequisite: TA 388. Credit, 3 hours.

391 Airport Operation. Operational functions; commercial airlines, general aviation operations, terminal building utilizations, support facilities, community relationships and airport financing. Prerequisite: TA 384. Credit, 2 hours.

487 Aircraft and Aerospace Design. Analysis of design data for aircraft and aerospace vehicles; value analysis, production requirements and manufacturing techniques. Prerequisites: TA 300, 305, 388. Credit, 3 hours.

488 Airline and Flight Operations Management Air commerce related to transportation system; regulatory climate of airline and fixed base operations; career planning. Prerequisites: EC 201, MG 301. Credit, 3 hours.

490 Aerospace Systems Analysis. Research and development methods, feasibility, costs and needs of present and future space systems; cost reduction, value analysis and methodology. Prerequisites: TA 300, 390. Credit, 3 hours.

491 Aviation Safety. Critical analysis of aircraft accidents, accident prevention, development and evaluation of aviation safety programs. Credit, 2 hours.

492 Aircraft Accident Investigation. Development and analysis of data, evaluation and recommendations for preventative practices. Prerequisite: TA 491. Credit, 3 hours.

493 Airline Administration. Administrative

organizations, economics of airline administration; operational structure, cost analysis, relationship with federal government agencies. Prerequisite: TA 488. Credit, 2 hours.

COMMUNICATIONS

CT 220, 221 Communication Processes. Composition, presentations, speech and technical reading. Credit, 3 hours each semester.

320, 321 Industrial Documentation. Integrates use of technical illustration, use of specifications, with industrial practices and production processes of handbooks and manuals. Credit, 3 hours each semester.

420 Technical Writing. Writing techniques, organization of material research methods for technical writers. Credit, 3 hours.

421 Technical Editing. Editing proposals, handbooks, manuals and reports. Credit, 3 hours.

ELECTRONIC TECHNOLOGY

TE 100 Electricity/Electronics. Electrical units, components, reactances, impedances, transformers, resonance, rotating equipment, power systems, vacuum tubes, and semiconductors. Two lectures, 6 hours laboratory. Credit, 4 hours.

101, 201 Applied Electrical Science. Circuit elements, simple and complex circuitry, network simplification, periodic functions, phasors and number systems for computers. Credit, 2 hours each semester.

215 Electro-Mechanical Processes. Modern circuit layout, bread-boarding, packaging and construction. Prerequisite: TE 100. Two lectures, 3 hours laboratory. Credit, 3 hours.

220 Radio Communications. Rules, regulations, circuitry and amateur procedures. International Morse Code. Prerequisite: TE 100. One lecture, 3 hours laboratory. Credit, 2 hours.

230 Active Devices. Semiconductor devices including diodes and triodes. Principles of

vacuum tubes including diodes, triodes and other multi-element tubes. Prerequisite: TE 100. Two lectures, 3 hours laboratory. Credit, 3 hours.

300 Circuits I. Theory and applications of circuit components. Study of resistors, capacitors, and inductors in various circuit configurations. Prerequisite: TE 201. Two lectures, 3 hours laboratory. Credit, 3 hours.

301 Circuits II. Continuation of TE 300 with emphasis on theory and applications of RCL circuits when operating on alternating current. Prerequisite: TE 300. Two lectures, 3 hours laboratory. Credit, 3 hours.

320 Audio Systems. Industrial sound and noise problems, frequency response, decibels and volume units, attenuators, amplifiers, and recording systems. Prerequisite: TE 230. Two lectures, 3 hours laboratory. Credit, 3 hours.

330 Solid State Electronics. Semiconductor devices; diodes, triodes, tetrodes, special devices and characteristics. Prerequisite: TE 230. Two lectures, 3 hours laboratory. Credit, 3 hours.

331 Switching and Waveshaping Circuits. Electronic circuits in which active devices operate in switching modes. Circuits include: clippers, clampers, multivibrators and logic. Prerequisite: TE 330. Two lectures, 3 hours laboratory. Credit, 3 hours.

340 Electronic Measurements. Application of electronic test instruments. New methods in measurement, using digital and programmed devices. Prerequisite: TE 230. Two lectures, 3 hours laboratory. Credit, 3 hours.

341 Precision Measurements. Laboratory standards, calibration, tolerances, galvanometers, potentiometers, bridges and other precision measurement equipment. Prerequisites: TE 301, 340. Two lectures, 3 hours laboratory. Credit, 3 hours.

360 Instrumentation Fundamentals. Basic principles of industrial control systems and devices such as transducers, recorders, motors, synchros and servos, data storage

and numerical control. Prerequisite: TE 230. Two hours lecture, 3 hours laboratory. Credit, 3 hours.

370 Electronics for Modern Man. Fundamentals of electricity and electronics. Active devices, semiconductors and vacuum tube principles. Applications of electronics to the sciences, communications and general education areas. For the nonelectronic major. Two lectures, 3 hours laboratory. Credit, 3 hours.

375 Electrical Power. Commercial and residential wiring systems and practices, including low voltage and standard systems, single and polyphase power distribution, National Electrical Code. Credit, 3 hours.

400, 401 Circuit Analysis. Network theorems, analysis, LaPlace transformations, and Fourier analysis. Complex network theorems and analysis. Prerequisites: TE 301, MA 142. Credit, 3 hours each semester.

412 Microwaves. Spectrum, waves, use of Smith charts, measurement techniques. Prerequisites: TE 301, MA 142. Credit, 3 hours.

413 Microwave and Optical Electronics. Transmission lines, waveguides, devices and laser fundamentals with applications to electronics. Prerequisite: TE 412. Credit, 3 hours.

415 Television. Synchronizing circuits, video amplifiers, and picture tubes in systems applications. Prerequisite: TE 330. Two lectures, 3 hours laboratory. Credit, 3 hours.

418 Communication Circuits. Amplitude modulation, frequency modulation and transmitter circuits emphasizing requirements needed for a second class FCC license. Prerequisite: TE 330. Two lectures, 3 hours laboratory. Credit, 2 or 3 hours.

419 Communication Systems. Television and single sideband transmitters, antennas and space communications emphasizing requirements needed for a first-class FCC license. Prerequisite: TE 418. Two hours lecture, 3 hours laboratory. Credit, 2 or 3 hours.

430, 431 Computer Systems. Principles of

logic circuits; binary arithmetic, counter circuits, and memory circuits used in computer systems. Prerequisite: TE 331. Two lectures, 3 hours laboratory. Credit, 2 or 3 hours each semester.

440 Electronics for Instrumentation. Electronics in instrumental devices, systems control, and numerical control. Prerequisites: TE 301, 360. Two lectures, 3 hours laboratory. Credit, 3 hours.

441 Control Systems Analysis. Design and application of instrumental control for processes or systems of related processes; control of resistive loads, magnetic amplifiers, saturable reactors, amplidyne, logic control systems, frequency responses of components, feedback controllers and their responses. Prerequisite: TE 440. Two lectures, 3 hours laboratory. Credit, 3 hours.

450 Integrated Circuits. Fundamentals, applications of linear and digital integrated circuits for communications, computation and control systems design. Prerequisite: TE 330. Credit, 3 hours.

470 Electronics for Modern Man. Continuation of TE 370. Electronic circuitry in communications, controls, instrumentation telemetry. For the nonelectronic major. Prerequisite: TE 370. Two lectures, 3 hours laboratory. Credit, 3 hours.

475 Television Broadcast Systems. Equipment operation and care, components, systems, camera chains, film chains, signal distribution. Two lectures, 3 hours laboratory. Credit, 3 hours.

476 Electronic Display Systems. Current applications of display systems to the general area of electronics, including CRT and biomedical displays, spectrum analyzers, vector scopes and computer displays. Credit, 3 hours.

GRAPHIC ARTS

GA 135 General Graphic Arts. Type composition, strike-on composition, presswork, book-binding, porous printing, flexography applica-

tion and duplicating. One lecture, 5 hours laboratory. Credit, 3 hours.

136 Graphic Arts Processes. Letterpress presswork, photo-offset lithography, photo screen, intaglio and production techniques. One lecture, 5 hours laboratory. Credit, 3 hours.

236 Layout and Printing Design. Specification interpretation, principles of typographic layout. Preparation of roughs, working layouts and comprehensive. Credit, 3 hours.

237 Imposition and Stripping. Typographic planning. Offset lithography and letterpress activities. One lecture, 5 hours laboratory. Credit, 3 hours.

238 Copy Preparation. Visualizing and preparing copy for photographic reproductions. Cold and hot type techniques. One lecture, 5 hours laboratory. Credit, 3 hours.

333 Offset Lithography (Presswork). Planography and operation of the offset press. Etches, gums, solvents. One lecture, 5 hours laboratory. Credit, 3 hours.

334 Offset Lithography (Camerawork). Materials, methods and equipment used in the production of photographic negatives and positives for offset lithography; line and half-tones. One lecture, 5 hours laboratory. Credit, 3 hours.

336 Color Separation. Methods of producing separation negatives. Prerequisite: GA 334 or approval of instructor. One lecture, 5 hours laboratory. Credit, 3 hours.

337 Production Management. Various systems used in the graphic arts industry for planning and controlling work flow. Credit, 3 hours.

339 Estimating and Cost Analysis. Estimating printing operations and materials; elements of cost finding using selected systems. Credit, 3 hours.

435 Plant Management. Independent documentary research; problems in equipment and personnel selection, plant site selection and layout and recent developments in production management. Credit, 3 hours.

436 Technical and Research Problems. Individual activities involving investigation and experimentation. Two lectures, 4 hours laboratory. Credit, 3 hours.

438 Graphic Arts Techniques and Processes. Graphic arts production. Complex technology of paper, ink and related materials with reference to printing processes. Two lectures, 4 hours laboratory. Credit, 3 hours.

INDUSTRIAL DESIGN

ID 100 Introduction to Design. Presentation of history, philosophy, principles, and influence of industrial design. The designer's past, present, future role in society. Credit, 2 hours.

111 Technical Graphics. Elements of orthographic and axonometric projection; charts and graphs, graphical mathematics; basic descriptive geometry. Two lectures, 3 hours laboratory. Credit, 3 hours.

112 Surface Definition. Descriptive spatial relationships between points, lines and planes. Techniques presented for developing complex, double-curved surfaces and intersections. Prerequisite: ID 111. One lecture, 3 hours laboratory. Credit, 2 hours.

121 Technical Analysis and Design. Technical problem analysis, design, implementation, organization and presentation. The slide rule, calculator and computer are used in problem solving. Two lectures, 3 hours laboratory. Credit, 3 hours.

160 Sketching Techniques. Free-hand drawing and sketching; shade and shadow; pen and pencil techniques. Emphasis upon quick, visual presentations of objects and concepts. One lecture, 3 hours laboratory. Credit, 2 hours.

161 Design Illustration. Illustration and rendering techniques; introduction of color using various media for presentation of three dimensional products. Fundamentals of perspective drawing. Prerequisite: ID 160. One lecture, 3 hours laboratory. Credit, 2 hours.

200 Descriptive Drawing. Descriptive drawing of products and components. Influence of manufacturing on form and shape. Detailing standards; dimensioning. Use of reference standards. Prerequisite: ID 112. One lecture, 5 hours laboratory. Credit, 3 hours.

201 Descriptive Drawing. Continuation of ID 200. Emphasis upon process design; tolerancing. Layout and functional arrangement of components. One lecture, 3 hours laboratory. Credit, 2 hours.

210 Human Factors in Design. Human factors considerations in equipment design. Man-machine-environment systems. Design requirements for specific populations. Credit, 3 hours.

215 Materials. Material usage in product and mechanical design. Emphasis on nonmetallic materials — plastics, elastomers, ceramics, glass. Environmental considerations. Prerequisite: MT 101. Credit, 3 hours.

250 Prototype Construction. Techniques of developing product models and prototypes. Experience in clay, plaster, foam, plastic. Emphasis on product appearance and surface finish. Prerequisite: ID 112. One lecture, 3 hours laboratory. Credit, 2 hours.

260 Industrial Design. Integration of form, function, human factors, esthetics and materials into the redesign of simple consumer products. Relationships between shape, use, texture, color; from initial sketch to final model. Prerequisite: ID 161. One lecture, 5 hours studio. Credit, 3 hours.

261 Industrial Design. Continuation of ID 260. Innovative development of new shapes for existing functions. Problems in creative product design and model development. One lecture, 3 hours studio. Credit, 2 hours.

301 Product Design. Design/development of mass-produced consumer products. Preliminary design sketches through final solutions including renderings and models. Understanding the determinants of component layout and arrangement. Prerequisite: ID 261. Two lectures, 6 hours studio. Credit, 4 hours.

302 Product Design. Continuation of ID 301. Increased complexity of problems. Marketing considerations; human factors emphasized. Problems selected from various areas such as power tools, appliances, transportation and biomechanical devices. Two lectures, 6 hours studio. Credit, 4 hours.

303 Computer-Aided Design. Introduction to computer aided design; systems, hardware, plotting equipment. Plotting programs developed and artwork generated. Prerequisite: EE 226. Credit, 3 hours.

305 Component Selection. Use of standard information data sources for product design component selection, specifications, operating parameters, standard motors, power transmission equipment, hardware, fasteners. One lecture, 3 hours laboratory. Credit, 2 hours.

306 Mechanical Design. Emphasis upon design/development of mechanical elements. Strength factors, safety factors, cyclic loading. Prerequisite: ID 201. Three lectures, 3 hours laboratory. Credit, 4 hours.

307 Mechanical Design. Continuation of ID 306. Design/development of mechanical sub-assemblies, brakes, clutches, couplings. Three lectures, 3 hours laboratory. Credit, 4 hours.

310 Applied Mechanics. Statics. Vectors, force systems, friction, equilibrium, centroids and moments of inertia. Prerequisites: MA 120 or 142; PH 111. Credit, 3 hours.

311 Applied Mechanics. Strength of materials. Deformation of members and bodies under stress. Prerequisite: ID 310. Credit, 3 hours.

340 Fluid Mechanics. Static and dynamic properties of fluids. Flow measurement and fluid control design. Prerequisites: PH 111, MA 120 or 142. Credit, 3 hours.

350 Graphic Design. Communications using graphic elements such as line, plane, color, value and harmony. Visual design as it relates to products, packages, displays, signage and posters. Mixed media. Two lectures, 4 hours studio. Credit, 3 hours.

351 Package Design. Structural and esthetic

considerations of containing, protecting and promoting the product through packaging; materials in packaging. Projects carried from initial idea to final prototype. One lecture, 4 hours studio. Credit 2 hours.

360 Applied Dynamics. Masses, motion kinematics, and dynamics of machinery. Prerequisite: ID 310. Credit, 3 hours.

370 Tool Design. Jigs and fixtures, punches and dies. Prerequisite: ID 111. Two lectures, 3 hours laboratory. Credit, 3 hours.

402 Value Analysis. Value appraisal and increase techniques through operational investigation of function and cost, critical investigation of design-manufacturing interface in component development. Case histories. Credit, 2 hours.

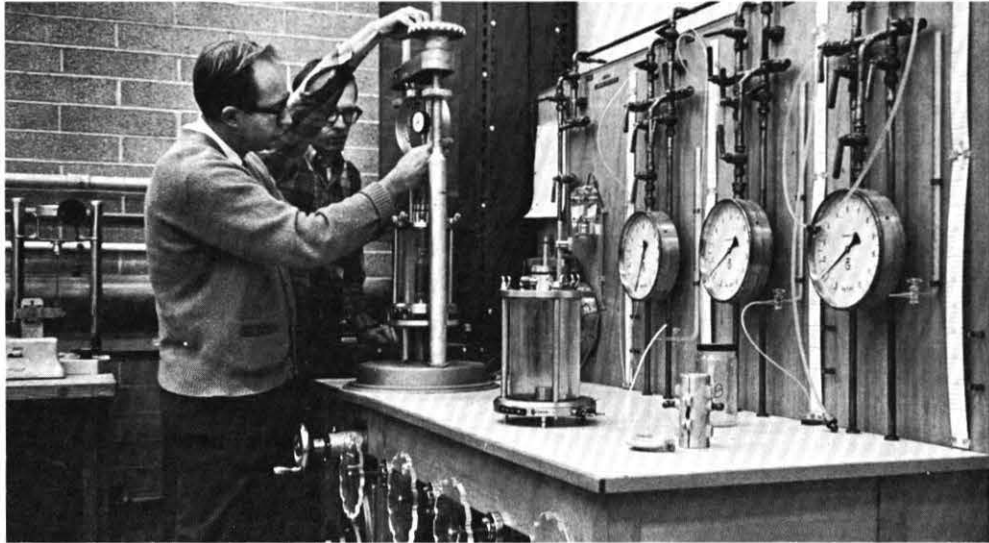
403 Product Usage and Liability. Manufacturer's liability in product development. Product usage; warranties; safety standards; liability claims; legislation. Credit, 2 hours.

406 Mechanical Design. Design of mechanical equipment. Integration of kinematics, human factors, materials and layout of components into total design concept. Creative redesign of existing industrial products. Three lectures, 3 hours laboratory. Credit, 4 hours.

407 Mechanical Design. Continuation of ID 406. Innovative design in broad area of product development. Problems selected from medicine, physical therapy, transportation, etc. Three lectures, 3 hours laboratory. Credit, 4 hours.

430 Product Design. Advanced product design techniques. Total planning from definition of need and organization of activities to final presentation to a design jury. Creative solutions to problems in fields such as electronic, sporting, recreation or medical. Six hours studio. Credit, 2 hours.

431 Product Design. Continuation of ID 430. Final senior design project. Creative solutions to major problems such as industrialized housing, mass transit, etc. Six hours studio. Credit, 2 hours.



Civil Engineering Laboratory Project

450 Design Integration. Large scale, interdisciplinary project design involving significant efforts of project planning and control, design, prototype development, feasibility study reporting. Two lectures, 3 hours laboratory. Credit, 3 hours.

451 Design Integration. Continuation of ID 450. Design finalization, model, final technical and summary reports, graphics, and oral presentation of results. Two lectures, 3 hours laboratory. Credit, 3 hours.

471 Package Design. Continuation of ID 351. Package testing, cushioning; industrial standards; materials in packaging. Prerequisite: ID 351. Credit, 2 hours.

MANUFACTURING ENGINEERING TECHNOLOGY

MT 101 Manufacturing Processes and Materials. Modern manufacturing operations, procedures, processes and materials emphasizing their

industrial applications. Two lectures, 3 hours laboratory. Credit, 3 hours.

110 Welding Survey. Oxy-acetylene, arc, brazing, and tungsten inert gas (TIG) welding procedures for ferrous and nonferrous metals, emphasizing low temperature alloys. Two lectures, 4 hours laboratory. Credit, 3 hours.

111 Arc Welding Procedures. Processes related to arc welding such as submerged arc and heli-arc welding procedures emphasizing electrode selection and material analysis. Prerequisite: MT 110. Two lectures, 4 hours laboratory. Credit, 3 hours.

116 Aeronautical Welding. Oxy-acetylene and inert gas welding chrome molybdenum, stainless and aluminum. Low temperature brazing, adhesive bonding. Two lectures, 4 hours laboratory. Credit, 3 hours.

200 Manufacturing Processes. Metal removal processes and procedures emphasizing the calculation of speeds and feeds as related to lathe, milling and drilling operations. Two lectures, 4 hours laboratory. Credit, 3 hours.

201 Manufacturing Processes. Physical and thermal properties of ferrous and nonferrous metals as related to milling, grinding and shaping operations. Tool geometry and design also emphasized. Two lectures, 4 hours laboratory. Credit, 3 hours.

210 Inert Gas Welding Procedures. Inert gas welding procedures emphasizing metallic inert gas (MIG) and tungsten inert gas (TIG) welding procedures used on nonferrous metals and alloys. Prerequisite: MT 110. Two lectures, 4 hours laboratory. Credit, 3 hours.

300 Production Tooling Fabrication. Fabrication and design of jigs and fixtures and special industrial tooling related to modern manufacturing methods emphasizing milling, shaping, and grinding problems. Prerequisite: MT 200. Two lectures, 3 hours laboratory. Credit, 3 hours.

301 Manufacturing Analysis. Economics and productivity of manufacturing methods and machines. Total manufacturing system studied with emphasis on computer control as

on automatic manufacturing system. Credit, 2 hours.

302 Mineralogical Machining Processes. Modern industrial methods of metal removal with the use of abrasives, emphasizing surface, tool and cutter and cylindrical grinding methods and types of abrasives used. Prerequisite: MT 200. Two lectures, 3 hours laboratory. Credit, 3 hours.

303 Manufacturing Systems. Manual, semi-automatic, numerical control and computer control systems and their applications in modern manufacturing systems with emphasis trends. Credit, 3 hours.

304 Finishing Processes for Metals. Industrial finishing methods used on ferrous and non-ferrous metals, emphasizing anodizing and plating operations and new finishes used in industrial applications. One lecture, 3 hours laboratory. Credit, 2 hours.

310 Advanced Welding Procedures. Theory and application of modern welding fabrication methods — electron beam, thermit, laser beam, and ultrasonic — emphasizing equipment and weld design. Prerequisite: MT 110. Two lectures, 3 hours laboratory. Credit, 3 hours.

311 Non-Destructive Testing. Modern testing procedures used in the welding industry, emphasizing radiography, X-ray diffraction and magnetic particle, ultrasonic and fluorescent particle inspection. Two lectures, 3 hours laboratory. Credit, 3 hours.

400 Numerical Control Manual Programming. Concepts of numerical control as related to point to point and continuous path systems. Methods of programming, set up and operation of two- and three-axis machines. One lecture, 3 hours laboratory. Credit, 2 hours.

401 Metrology and Quality Control. Precision measurement methods and quality control applications related to production, emphasizing gaging equipment, surface roughness, thermal expansion, stress, strain and destructive and nondestructive testing. Credit, 3 hours.

402 New Production Processes. Modern industrial processes used in the metalworking industry, emphasizing the chipless machining processes of electrical discharge machinery (EDM), electrochemical machining (ECM), chemical milling and etching. Two lectures, 3 hours laboratory. Credit, 3 hours.

403 Numerical Control Computer Programming. Applications of computer-aided programming for point-to-point and continuous path methods of numerical control, emphasizing the APT, AD-APT and AUTOSPOT computer languages. Two lectures, 3 hours laboratory. Credit, 3 hours.

404 Material Analysis and Testing. Physical, mechanical, and chemical properties of ferrous and nonferrous metals emphasizing metallurgy and testing procedures for hardness, stress, strain and tensile strength. Two lectures, 3 hours laboratory. Credit, 3 hours.

410 Metallurgy of Welded Metals. Microscopic and macroscopic examination of metals during and after welding, emphasizing metallurgical changes due to temperature changes, cooling, and alloying elements in ferrous and non-ferrous metals. Two lectures, 3 hours laboratory. Credit, 3 hours.

411 Welding High Temperature Alloys. Equipment, materials and methods for welding high temperature alloys such as cobalt, molybdenum, tungsten, titanium and columbium. Two lectures, 3 hours laboratory. Credit, 3 hours.

412 Design of Weldments. Static and dynamic loading, strength considerations of ferrous and nonferrous weldments. Prerequisite: ID 311. Credit, 3 hours.

INDUSTRIAL TECHNICAL EDUCATION

IT 121 Industrial Construction Processes. Wood fabrication processes, materials of construction, construction technology, product development. One lecture, 5 hours laboratory. Credit, 3 hours.

160 General Metals. Properties, tools and machines, welding, casting, production enter-

prise. One lecture, 5 hours laboratory. Credit, 3 hours.

170 Power Conversion. Sources of energy, design of mechanisms for power, electrical, mechanical, and chemical. One lecture, 3 hours laboratory. Credit, 2 hours.

174 Transportation Systems. Historical development, land, air, water systems. Two lectures, 3 hours laboratory. Credit, 3 hours.

204 Industrial Arts Design. Design principles and problems; construction drafting. Prerequisite: ID 111. One lecture, 3 hours laboratory. Credit, 2 hours.

222 Wood Technology. Forestry products, construction processes, testing, strength of materials, laminations, industrial applications. Prerequisite: IT 121. One lecture, 5 hours laboratory. Credit, 3 hours.

270 Fluid Power. Principles and techniques. Demonstration and operation of hydraulic and pneumatic circuits and components, and the basic laws and principles by which they operate. Prerequisite: IT 170. Two lectures, 3 hours laboratory. Credit, 3 hours.

273 Automotive Electrical Equipment. Principles, specifications, and circuitry. Two lectures, 3 hours laboratory. Credit, 3 hours.

326 Cellulose Materials. Forming, laminating, adhesion, bend allowances, structural design and testing. Two lectures, 3 hours laboratory. Credit, 3 hours.

346 Modern Technology and Civilization. Forces leading to growth of American industries, production systems, unions, occupations, problems of technological change, interrelationships of men, materials, and processes. A nontechnical course for nonmajors and majors. Credit, 2 hours.

361 Industrial Crafts. Design and activities in plastic, leather, lapidary, lost wax process, wood and metal. One lecture, 3 hours laboratory. Credit, 2 hours.

371 Automotive Construction Materials. Coating, finishing, forming and shaping to measurements, styling, modern plastics and metals,

electroplating, anodizing, effects of heat, wear and corrosion. Two lectures, 4 hours laboratory. Credit, 3 hours.

377 Internal Combustion Engines. Principles, cylinder pressures, engine design, flame temperature, combustion phenomena; machine processes. One lecture, 5 hours laboratory. Credit, 3 hours.

401 Vocational Education in American Schools. Basic principles and philosophies of vocational education. Relationship of vocational education to general education, history and legislation. Credit, 3 hours.

402 Analysis and Course Development. Selecting learning units through analysis technique and industrial technical course development. Credit, 3 hours.

405 Improving Instruction in Drafting. Methods, evaluation, industrial practices, drafting problem sequences, and equipment. Credit, 3 hours.

421 Production Wood Technology. Product and process design, material handling, jigs and fixtures, work environment, personnel, quality control, assembly, finishing in wood technology. One lecture, 5 hours laboratory. Credit, 3 hours.

423 Industrial Arts for Elementary Teachers. Tool and material centered activities related to teaching children about technology; classroom problems; integrated instruction; instructional aids. One lecture, 5 hours laboratory. Credit, 3 hours.

424 Techniques of Construction. Buildings, nonbuildings, planning, site preparation, structure, construction materials, personnel. One lecture, 5 hours laboratory. Credit, 3 hours.

427 Industrial Plastics. Fabrication techniques, physical qualities manufacturing processes, injection molding, vacuum forming, welding, lamination, casting. One lecture, 5 hours laboratory. Credit, 3 hours.

442 Facility Planning and Management. Planning, organizing and managing industrial technical education laboratories; equipment

and supply selection, facility arrangement. Credit, 3 hours.

443 Industrial Safety. Accident prevention, accident factors, methods of recording and reporting, analysis, psychological aspects, attitudes, safety consciousness and liability. Credit, 3 hours.

444 Modern Industries. Aspects of management, labor, plant and product; for interpretation of industry in secondary school industrial education program. Credit, 3 hours.

445 Industrial Internship. Assignment commensurate with student's instructional program. Manufacturing processes, technical information, instructional techniques, management experiences, specialized instruction by industry. Prerequisite: approval of department chairman. Credit, 1-10 hours.

446 Instructional Aids and Materials. Selection, preparation, construction and methods of use in industrial technical education. Credit, 3 hours.

461 Hot Metals Techniques. Properties of metals; nonferrous casting; pattern making; metal finishing. Two lectures, 3 hours laboratory. Credit, 3 hours.

465 General Metals. Numerical control, electroplating, metal spinning, chipless machining, study in areas of special interest. Prerequisite: IT 160. One lecture, 5 hours laboratory. Credit, 3 hours.

478 Engine Analysis. Evaluation, power, instrumentation, fuels and fuel mixtures. Prerequisites: IT 174, 273 or equivalent. Two lectures, 3 hours laboratory. Credit, 3 hours.

480 Teaching Industrial Technical Subjects. Teaching techniques, philosophy, organization, planning, evaluation of teaching efficiency. Credit, 3 hours.

491 Organization and Management of Cooperative Programs. Workstudy programs for industrial technical occupations in high schools and junior colleges. Developing and coordinating programs. Instructional materials. Credit, 3 hours.

502 Industrial Technical Program Development. Improvement and development of programs for secondary and post-secondary institutions. Credit, 3 hours.

513 Experimental Activities. Investigation and solution of selected industrial arts activities and projects involving material design and analysis. Credit, 3 hours.

515 Electrical Laboratory Design. Studies of school laboratories for electricity and electronics equipment, materials, instructional aids. Credit, 3 hours.

540 Evaluation in Industrial Technical Education. Evaluative factors such as attitudes, behavioral factors, skills, technical information; instrument construction; evaluation of program effectiveness. Credit, 3 hours.

541 Adult Vocational Programs. Organizing and administering evening and adult industrial technical programs. Formal and informal school and industry offerings. Credit, 3 hours.

542 Philosophy of Industrial Technical Education. Current concepts, anticipated policies, practices and objectives in practical arts and vocational-technical education. Credit, 3 hours.

543 Training Programs in Industry. Organization and administering of industrial technical training programs. Credit, 3 hours.

544 History of Industrial Technical Education. Factors motivating evolution of modern programs; implication for future; trends. Credit, 3 hours.

546 Technical Education. Trends, community surveys, need, curricula, instruction, evaluation of technical programs, financing, emphasis on 13th and 14th years. Credit, 3 hours.

548 Administration of Industrial Technical Education. Improving instruction, fund and material control, student personnel problems, curricular patterns. Credit, 3 hours.

549 Current Literature and Research. Analysis of literature, individual investigations, trends in industry, local, state and federal programs. Credit, 3 hours.

College of Architecture

JAMES W. ELMORE, M.S. IN ARCH.

Dean

Purpose

The College of Architecture seeks to enable each of its graduates to acquire: (a) a thorough and intimate comprehension of the nature of architecture; (b) the competence necessary to achieve professional registration; (c) the high ideals necessary for responsible and creative functioning as an individual and as an architect in our changing society.

Affiliations

The program is accredited by the National Architectural Accrediting Board and provides educational qualification for registration under Arizona law as administered by the State Board of Technical Registration in conformity with the recommendations of the National Council of Architectural Registration Boards. The College is a member of the Association of Collegiate Schools of Architecture. The Architecture Foundation provides for enrichment of programs through administration of the supporting contributions of various private associations, firms and individuals. The Central Arizona Chapter of the American Institute of Architects lends support in many ways.

Concept of the Program

Recognizing the student's need for at least one year of college-level work to identify or verify his interest and aptitude for architecture, the five-year Bachelor of Architecture curriculum is divided into a one-year *pre-architecture* program and a four-year *professional* program.

The pre-architecture program consists of at least one year of college-level work completed at another institution or in one of the other colleges of Arizona State University, normally the College of Liberal Arts. Most of the 30 semester hours required, as listed in the following section on *Admission*, satisfy requirements for any baccalaureate degree at the University. The specified architecture and art studio courses enable the student to investigate the nature and career possibilities of architecture and environmental design. At the time of entrance, the student declares a *coordinate focus* that will give structure to his elective choices and that might supplant architecture as his primary academic objective should it develop to be more challenging to his interests and talents. Admission to the pre-architecture program at ASU implies no commitment to or assurance of later admission to the College of Architecture. Advisement procedures for this program are described on page 55.

The professional program consists of courses in architectural philosophies, technologies and design, with emphasis on the latter. The objective of the design/synthesis sequence is two-fold: first, to introduce and promote cumulative synthesis of the full spectrum of architectural problem-solving processes and, second, to assist the student in advancing his professional capabilities and focusing them in areas of significant human concern. Through the process of solving a variety of architectural and other problems, with faculty guidance and in competition with his peers, the student lays an academic foundation for those personal techniques and philosophies that he will develop through perhaps 45 years of apprenticeship and practice in a rapidly changing profession.

Program limitations exist because the College believes that it can provide the highest quality of architectural education if it remains relatively small and limits the number of students working with each critic in each design studio. The new Architecture Building, first occupied in 1970, can accommodate approximately 300 students in its 16 studios. Within the capability of available faculty, space and resources, the College seeks to provide opportunity for the maximum number of qualified students; accordingly, it evaluates all applications with the object of selecting those who have a reasonable prospect of success in the rigorous and demanding courses of study.

Admission

Dates. For Fall admission, students must complete all application requirements prior to July 1; for Spring admission, prior to December 1.

Admission to the College of Architecture is subject to the above program limitations and requires:

- a) Admission to Arizona State University
- b) Completion of the following courses or their equivalents:

1 EN 101	First Year English	.....	3
1 EN 102	First Year English	.....	3
1 MA 142	Math Analysis	.....	4
1 PH 111	General Physics	.....	4
5 AP 100	Introduction to Architecture		2
5 AP 101	Fundamentals of Environmental Design	....	2
0 AR 111	Beginning Drawing	.....	3
0 AR 141	Basic Design	.....	3
	Other	.....	6
			30

- c) Scholarship index at a level of achievement giving the applicant reasonable prospect for success in the professional program and in no case less than 2.00.
- d) Submission to the Dean's office of application form and portfolio of applicant's work evidencing superior design and creative capabilities beyond drafting skills.
- e) Satisfactory completion of course work prerequisite to the level sought, if the applicant is seeking advanced standing.

Notification of Admission Status – Students not academically qualified will be so notified promptly following receipt of transcripts. Those whose applications are complete by July 1 will be advised by about July 15 as to their admission status. Qualified students completing their applications after July 1 may be admitted if positions remain available. Late applicants should allow at least one month from completion of their applications to notification of their status.

Advancement and Retention

Advancement from one design/synthesis course to the next requires:

- a) A grade of "C" or better and recommendation of the critic in the last completed design/synthesis course.
- b) Satisfactory completion of all prerequisite courses.
- c) Cumulative index of 2.00 or above.

Retention in the Bachelor of Architecture program of a student not meeting the above standards for advancement in the design/synthesis sequence requires action by the College Admissions and Standards Committee. If a student's request for permission

to enroll in professional courses other than design is approved, he and his advisor will be so notified. If not, he may remain and be advised in the B. Arch. program for a period of one semester while he completes transfer to another curriculum.

Scholarships

Apart from those given by the University generally, scholarships are awarded only on the basis of work done while enrolled in the College of Architecture.

Special Requirements

Work done in satisfaction of all degree requirements becomes the property of the College; when not required for exhibit or reference, it may be returned to the student. Two bound copies of the student's thesis research must be furnished to the architecture library.

Bachelor of Architecture Degree Curriculum

A student seeking the Bachelor of Architecture degree must satisfactorily complete a curriculum of 170 semester hours, including basic military science or aerospace studies if elected. The requirements in the major categories of course work are recapitulated as follows:

Communications – The University requirement for Freshman English is on page 29.

English: EN 101, 102 (or 104 and elective) 6

General Studies provide a broadening and enrichment of the student's outlook and a preparation for the technical and professional content of the program to follow. The Uni-

versity requirements in General Studies, as further described on page 28, are:

Humanities and fine arts	8
Social and behavioral sciences	8
Sciences and mathematics	8
Electives in the above areas	12

36

Architectural Philosophies (AP) develop understanding of architecture as both a consequence and a determinant of man's character, in the past (history) and at present (theory). Required courses are:

Introductory: 100, 101, 201, 202, 203, 303	13
300 level electives	6
400 level electives	6

25

Architectural Technologies (AT) develop knowledge of the technical determinants, resources and processes of architecture. The required courses are:

Architectural communications: 241, 242, 341; OAR 111	11
Research methods: 342	2
Materials and techniques: 251, 451.	6
Contract documents: 452	2
Structures: 461, 462, electives	12
Mechanical and electrical systems: 445, 446	6
Professional seminar: 555, 556	4

43

Architectural Design/Synthesis (AD): Work in architectural design demands and encourages synthesis of the knowledge and understanding the student has gained from course work and all other sources. Required courses are:

Design/Synthesis: 221, 222, 321, 322, 421, 422; OAR 141	29
Field study: 520	1
Architecture Studio/Thesis: 523, 524	10

40

Electives enable the student to fortify weaknesses, exploit strengths and pursue special interests. Choices are made by the student with his advisor with the objective of increasing both his appreciation of the numerous areas of general and professional studies and his depth of understanding in several of them. Elective opportunities provided beyond those in the General Studies program are:

Electives	20
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<i>Total of normal ten-semester curriculum</i>	170
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Architecture

Professors:

ELMORE (ARCH. 134), STRAUB, ELLNER, WHIFFEN

Associate Professors:

BOYLE, COOK, FLYNN, HERSHBERGER, JAKOB, OLIVER, PETERSON, RAPP

Assistant Professors:

BALLEW, BERTELSEN, CORRIE, HINSHAW, MOFFITT, WOOLDRIDGE, YOUNG

Instructor:

BRITZ

Lecturer:

YELLOTT

ARCHITECTURAL PHILOSOPHIES

Unless otherwise indicated, these courses are open to any student meeting the stated pre- or co-requisites and are recognized in the University's program of General Studies.

AP 100 Introduction to Architecture. Understanding of our physical environment through the forms, functions and determinants of today's architecture, its continuity with the past and its relation to the developing present. Brief examination of architecture as a profession. Credit, 2 hours.

101 Fundamentals of Environmental Design. Interaction of the ecological, societal, human and formal determinants of the designed environment. Pre-architecture students only. Prerequisite: AP 100. Credit, 2 hours.

201 Formal Systems. Form in environmental design including gravity, construction, circulation, growth and esthetic systems for structuring form. Corequisite: AD 221 or 222. Credit, 2 hours.

202 Environmental Systems. Environmental control systems in design including water distribution, waste disposal, climate control, acoustics, lighting and communications. Co-requisite: AD 221 or 222. Credit, 2 hours.

203 Introduction to Landscape Architecture. Land and site planning; ecology as the basis of outdoor design; theory, techniques and material vocabulary. Corequisite: AD 221 or 222. Credit, 3 hours.

303 Introduction to Planning. Principles and techniques of planning; contemporary urban problems; redevelopment programs; new communities; federal programs; comprehensive plans. Corequisite: AD 221 or 222. Credit, 2 hours.

311 Evolution of Human Settlements. Land use and urban development as evidenced in planning and design from ancient to modern times. Credit, 3 hours.

312 The Man-made Environment. Esthetic, social, economic, political and other factors

shaping the designed environment of the 20th century. Credit, 3 hours.

313, 314 History of Architecture. An introductory survey of representative works of Western architecture. Ancient through Medieval in 313. Renaissance through the present day in 314. Credit, 3 hours each semester.

315 Topics in Architectural Philosophies. Developments, theories or achievements of current or special interest. Prerequisite: junior standing and approval of instructor. Credit, 1-3 hours.

401 Arid Region Architecture. Problems and solutions arising from architecture's participation in a desert ecology. Prerequisite: senior standing and approval of instructor. Credit, 2 hours.

402 American Architecture. Architecture in the U. S. from earliest colonial times to the present. Credit, 3 hours.

403 Oriental Architecture. Middle East, India, Southeast Asia, China, and Japan from ancient times to the present. Prerequisite: A' 100 or any AP 300-level course. Credit, 3 hours

404 Discussion Leadership. Experience of leading small groups in discussion of architectural subjects. Prerequisites: AP 101, AD 321, and approval of instructor in AP 101. Credit, 1 hour. May be repeated for a maximum of 3 credit hours.

405 Seminar. Discussion and reports on aspects of contemporary architecture: theory, practice, criticism. Prerequisites: AD 321 and 322. Credit, 2 hours.

411 Ancient Architecture. The ancient Mediterranean world, with selective emphasis on major historical complexes and monumental styles. Prerequisite: AP 100 or any AP 300-level course. Credit, 3 hours.

412 Medieval Architecture. Europe and the Near East from the reign of Constantine to the end of the Middle Ages. Prerequisite: AP 100 or any AP 300-level course. Credit, 3 hours.

413 Renaissance Architecture. Europe and America in the 15th and 16th centuries. Prerequisite: AP 100 or any AP 300-level course. Credit, 3 hours.

414 Baroque Architecture. Europe and America from the late 16th to the middle 18th century. Prerequisite: AP 100 or any 300-level course. Credit, 3 hours.

415 19th Century Architecture. Europe and America from neo-classicism to the art nouveau. Prerequisite: AP 100 or any AP 300-level course. Credit, 3 hours.

416 20th Century Architecture I. Europe and America from the foundations of the modern movement to the culmination of the international style. Prerequisite: AP 100 or any AP 300-level course. Credit, 3 hours.

417 20th Century Architecture II. Developments in architecture since the international style. Prerequisite: AP 100 or any AP 300-level course. Credit, 3 hours.

471 History of Landscape Architecture. Physical record of man's attitude toward the land. Ancient through contemporary land design for human use and enjoyment. Prerequisite: AP 100 or any AP 300-level course. Credit, 3 hours.

481 History of the City. The city from its ancient origins to the present day, with emphasis on the cities of Europe and America during the last five centuries. Prerequisite: AP 100 or any AP 300-level course. Credit, 3 hours.

ARCHITECTURAL TECHNOLOGIES

Unless otherwise indicated, these courses are open only to students admitted to the professional program of the College of Architecture. (See page 210.)

AT 241 Design Communications I. Theory of perception and design communications; perspective, shades and shadows; techniques of sketching and rendering; basic design principles. Two half-days in studio. Credit, 3 hours.

242 Design Communications II. Advanced techniques of design simulation including photographic, 3-D modeling, electronic and other techniques; graphic communications; basic design principles. Two half-days in studio. Credit, 3 hours.

251 Materials and Construction. Introduction to materials and their use in construction. One-half day in studio. Credit, 3 hours.

341 Computers in Environmental Design. Use and potential in such areas as programming, calculations, control, design and graphics. Credit, 2 hours.

342 Research Methods. Theory of science, problem definition, research design, techniques of observation and questioning, sampling procedures, experimental design, methods of analysis and interpretation of data. Credit, 2 hours.

361 Introduction to Structures. Elementary structural materials, principles and systems. Credit, 2 hours.

441 Computers in Architecture. Extension of prerequisite AT 341. Credit, 3 hours.

445, 446 Mechanical and Electrical Systems. Technical problems of climate control, acoustics, lighting, communications and other mechanical and electrical systems. Credit, 3 hours each semester.

451 Construction Systems. Selection and employment of materials and systems according to their nature and the techniques of their use. Prerequisite: AT 251. Credit, 3 hours.

452 Contract Documents. Developing systems used in the preparation of contract drawings, specifications and documents. Use of building codes and zoning ordinances. Prerequisite: AD 321. Credit, 2 hours.

461 Theory of Structures I. Elasticity of structural materials; properties of sections; elastic stress analysis of determinate structures; flow diagramming for computer programming (BASIC). Credit, 3 hours.

462 Theory of Structures II. Introduction to indeterminate structures; use of existing structural (computer) programs; structural engineering properties of wood, steel and concrete. Prerequisite: AT 461. Credit, 3 hours.

463 Structures of Wood and Masonry. Wood columns, beams and connections; masonry walls, columns and connections; truss analysis; computer programming (BASIC). Prerequisites: AT 461 and 462. Credit, 3 hours.

464 Structures of Steel. Continuous beams and rigid frames of steel, steel columns and connection design. Prerequisites: AT 461 and 462. Credit, 3 hours.

465 Structures of Concrete. Material characteristics; reinforced concrete mechanics; development of programs for beams, slabs and columns. Prerequisites: AT 461 and 462. Credit, 3 hours.

473 Landscape Construction and Materials. Design, construction, materials and site engineering aspects of landscape architecture. Prerequisite: AP 203. Credit, 3 hours.

483 Introduction to Urban Statistical Analysis. Quantitative analysis in the urban context, demographic analysis, data processing, planning applications and urban systems. Prerequisites: AD 202 and QS 221. Credit, 3 hours.

484 Introduction to Land Economics. Economic determinants for urban and regional planning; analytical techniques; elementary market studies and feasibility analysis; economic incentives in urban planning. Prerequisites: AD 202 and EC 202. Credit, 3 hours.

555 Professional Seminar I. Legal and ethical aspects of professional practice including partnerships, corporate practice, insurance, tax law, codes, ordinances and contract documents. Prerequisite: fifth-year standing. Credit, 2 hours.

556 Professional Seminar II. Economic and organizational aspects of professional practice including office management, field operations and control, financing and organization of

building operations, nature and organization of the construction industry. Prerequisite: fifth-year standing. Credit, 2 hours.

561 Soil Mechanics and Foundations. Soil characteristics; elementary soil mechanics, elementary foundation design, programming. Prerequisites: AT 461, 462 and 465. Credit, 3 hours.

562 Structural Materials and Systems Research. Empirical analysis of architectural and structural materials and systems. Individual or team research. Prerequisites: 9 hours of 400- or 500-level structures and approval of instructor. Nine hours of in-laboratory work per week. Credit, 3 hours.

ARCHITECTURAL DESIGN/SYNTHESIS

Unless otherwise indicated, these courses are open only to students admitted to the professional program of the College of Architecture. (See page 210.)

AD 221 Design/Synthesis — Ecological Determinants. Ecological, climatic, site and landscape determinants of design. Emphasis on methods of analysis. Three afternoons in studio. Credit, 4 hours.

222 Design/Synthesis — Human Determinants. Biological, psychological, cultural and functional determinants of design. Emphasis on methods of research and programming. Three afternoons in studio. Credit, 4 hours.

321 Design/Synthesis — Systems Determinants. Structural and environmental control determinants of design. Emphasis on methods of synthesis. Prerequisites: AD 221 and 222. Four afternoons in studio. Credit, 4 hours.

322 Design/Synthesis—Societal Determinants. The social, economic, and political determinants of design. Emphasis on methods of evaluation. Prerequisites: AD 221 and 222. Four afternoons in studio. Credit, 4 hours.

421, 422 Design/Synthesis. Advanced studio problems with alternative sections offering, as

resources permit, areas of concentration in building design, urban design, land planning, landscape design, interior design, product design, extreme climates design, industrialized building design, structures, housing, research, programming and production. Prerequisites: AD 321 and 322. Five afternoons in studio. Credit, 5 hours each semester.

423 Interdisciplinary Studio. Studio course for senior non-architecture students. Problems structured in accordance with the needs and capabilities of the students enrolled. Prerequisites: senior standing and permission of the Dean, College of Architecture. Credit, 3 hours.

424 Community Design Workshop. Approved program of design work with a local community workshop. May be taken as a fourth-year elective. Prerequisite: AD 322. Five afternoons a week. Credit, 5 hours.

520 Field Study. Organized study of architecture in an out-of-state setting. Corequisite: AD 521 or 522. Credit, 1 hour.

521, 522 Architecture Studio. Same as AD 421, 422. Prerequisites: AD 421 and 422. Five afternoons in studio. Credit, 5 hours each semester.

523, 524 Architecture Studio. Same as AD 421 and 422 but including thesis research and design sections. Prerequisites: AD 521, 522. Five afternoons in studio. Credit, 5 hours each semester.

College of Nursing

Purpose

The faculty of the College of Nursing acknowledges its responsibility to Arizona and the world community for the preparation of individuals who will provide nursing care of professional quality through teaching, research and service. The purpose of the College of Nursing is to provide an educational program which prepares practitioners to give nursing care which considers emotional, bio-physical, socio-cultural and ecological needs in the prevention and treatment of human ills. This nursing care is based upon the belief that all human life has dignity and worth, that there is potential for growth in every individual, and that every individual should have the opportunity to achieve and maintain health.

It is the belief of the College of Nursing that professional behavior is based upon a balance of liberal and special education, and that the professional nurse is committed to the utilization of knowledge and skills to help other human beings achieve and maintain well-being. In addition, the professional nurse acts as a change agent in a rapidly changing environment.

Organization

The College of Nursing is organized as follows:

BACCALAUREATE PROGRAM.

GRADUATE PROGRAM.

Community Mental Health-Psychiatric Nursing

Family-Child Nursing

Medical-Surgical Nursing

CONTINUING EDUCATION ACTIVITIES.

Many persons who desire to continue their studies while actively engaged in their

personal or professional nursing activities find it impossible to attend the regular sessions of the University. In response to this demand, the Continuing Education Committee of the College of Nursing offers two special types of services in collaboration with the University Extension Division. Extension classes are offered at various locations and special institutes and workshops are offered in cooperation with special groups or agencies.

Degrees

Bachelor's Degree. The completion of a four-year curriculum in nursing leads to the degree of Bachelor of Science in Nursing.

Master's Degree. The College of Nursing offers a four-semester program leading to a Master of Science in Nursing degree with specialization in Community Mental Health-Psychiatric Nursing, Family-Child Nursing, and Medical-Surgical Nursing. Requirements for these programs are given in the Graduate College catalog. Persons interested in applying for admission to the program should write to the Arizona State University Graduate College for a catalog and application forms.

Bachelor of Science in Nursing. The purpose of the undergraduate program in nursing at Arizona State University is to prepare a graduate who possesses general clinical competence to perform as a beginning professional nursing practitioner in any health care setting. The graduate is prepared to give direct patient care to individuals and families, using systematic observation, assessment, decision-making and evaluation skills, culminating in enlightened and dynamic nursing action. The graduate is prepared to teach responsibly about health practices, to function as a leader of small health groups, to

collaborate with other professionals in the health field. The graduate is prepared as a responsible agent to continue functioning as an inquiring person.

Students admitted to the nursing program will follow the course of study suggested in the College of Nursing *Bulletin* at the time of their admission.

The Bachelor of Science in Nursing degree is granted upon completion of 126 semester hours. The nursing program consists of completing the General Studies requirements of Arizona State University, selected non-nursing courses and the major in Nursing. Nursing courses are designed to provide experiences based on health-illness, bio-psycho-social needs and age continua.

Students without previous nursing course work can usually complete the plan of study leading to the Bachelor of Science in Nursing in four academic years. Students with previous nursing course work and/or experience may complete the program of study in less than four academic years.

Some students, however, may find it advantageous or necessary to devote more than the usual time to the undergraduate nursing program of study by pursuing fewer studies in any one semester than are regularly prescribed. In cases involving inadequate secondary preparation or financial necessity requiring time for outside work, time for the undergraduate course should be extended. A student who so desires may devote an increased length of time to this undergraduate work and include additional instruction in the liberal arts.

Requirements for Admission and Retention.

The program is designed to meet the academic needs of freshman students and transfer students from other programs within the University or from other educational

institutions. Persons interested in applying for admission should write to the Director of Admissions, Arizona State University.

1. Freshman students must meet University standards and follow the procedure as stated in the Admissions section of the current University *General Catalog*. In addition, the high school program of the student wishing to register in nursing must include algebra, advanced algebra and an additional unit of mathematics for a total of 2½ units; laboratory sciences must include 1 unit of biology and 1 unit of chemistry or their equivalent; an additional unit of physics is recommended.

2. Transfer students must meet the retention standards of the University and follow the procedure for admission to the University as stated in the *General Catalog*, and, if transferring from another educational institution, also request the college to send a transcript to the Dean, College of Nursing. Transfer credits which are accepted by the Registrar will be evaluated by the College of Nursing Standards Committee to determine their application toward fulfilling the requirements of the nursing program.

3. Students who have completed nursing course work in a school of nursing and/or college should request that their previous institution(s) send two transcripts of their school of nursing work and/or previous college work – one directly to the Registrar and Director of Admissions and one to the Dean, College of Nursing. After the Dean, College of Nursing, has received all transcripts, the student should make an appointment for the evaluation of previous course work. Students may earn credit through comprehensive examinations in selected nursing courses. (See page 74.) A proficiency examination may be required for the validation of transfer

credits in nursing courses from another University.

4. Prior to enrolling in the nursing major, each nursing student must receive approval from the office of the Dean, College of Nursing, and secure from his advisor an approved course of study for the remaining work. A student must maintain a cumulative index of 2.00 (“C”), and must have completed all of the following prerequisites with a grade average of “C” or better in each category:

ENGLISH	(EN 101-102 or 104)
HUMANITIES	8 hours, including speech as outlined under General Studies program, pages 28-29.
SOCIAL SCIENCES	Psychology (PX 100) Sociology (SO 101 or 301) Anthropology (AN 101 or 102) Child Development (CD 232) Family Relationships (MF 331 or SO 305)
SCIENCE	Organic Chemistry (CH 231) Anatomy (ZO 201) Physiology (ZO 202) Microbiology (MI 201-202) Genetics (BI 340; ZO 300, 341) Nutrition (FN 141 or 444)

A student must also achieve a minimum grade of “C” in all nursing courses in order to remain in the nursing program. A student may repeat a course only one time.

5. All students must complete application for entrance into the major prior to enrolling in nursing courses. This may be completed during preregistration advisement period, but must be completed prior to registration week of the semester that entrance is desired. Application forms are available through advisors.

6. The physical examination must be completed and reports returned to the College

of Nursing by registration week of the semester the student is entering the nursing major, and yearly thereafter. When it is considered beneficial in program planning for the individual student, an additional statement of health may be required from the student's family physician. Forms are available in Nur 410 (see pages 13 and 33.)

General Information

Accreditation. The baccalaureate program of the College of Nursing has been approved by the Arizona State Board of Nursing and the National League for Nursing. The College is a member of the Council of Member Agencies for the Baccalaureate and Higher Degree Programs of the National League for Nursing, and the Western Council on Higher Education for Nursing. The College is approved by the Army Nurse Corps and the Navy Nurse Corps, so that qualified students may apply for the Army Student Nurse and Navy Student Nurse programs.

The Master of Science in Nursing program was first offered in September 1969. The College of Nursing has reasonable assurance of approval for accreditation from the National League for Nursing for this program.

Colloquia. Colloquia will be scheduled upon request from students who wish orientation to the nursing major.

Scholarships. For information regarding scholarships and loans, see page 35. Information about other loan funds for student nurses may be obtained from the Director of Financial Aids or the Dean of the College of Nursing.

Student Activities. The nursing student is a member of the general student body of the University, and selects and participates in those campus activities which are of interest

to him. Students are represented on University and College of Nursing committees.

Baccalaureate students of the College of Nursing are eligible for membership in ASASU, Arizona Association of Student Nurses and the National Student Nurses Association. Students are represented in the Student Senate of ASASU.

Student Health. In addition to the health policies of the University, the student enrolled in the nursing major is responsible for having an annual physical examination, annual chest X-ray and immunizations as necessary to maintain current immunizational status. A tuberculin skin test is given every six months unless a prior positive skin test has been recorded.

When it is considered beneficial in program planning for the individual student, a medical statement from the student's family physician may be required.

Student Transportation. The College of Nursing is located in close proximity to federal, state, county and private health agencies used for selected clinical experiences with patients and families. Students will provide their own transportation to the health agencies and other selected experiences, such as home visits to patients and families.

Registered Nurse Students. Registered Nurse students are encouraged to enroll in the baccalaureate program. College transcripts will be evaluated on an individual basis.

Honors Program. The Honors Program in the baccalaureate program of the College of Nursing is open to students who have completed one semester as a full-time student at Arizona State University with a grade point index of 3.25. An Honors student must complete at least 12 semester hours in Honors

courses, including 3 semester hours in an Honors Nursing course. Students interested in the Honors Program should consult with their advisors.

Nursing

Professors:

_____(Nur 459), BRANSTETTER,
JOHNSON, McLEOD

Associate Professors:

BRUNER, CORONA, HOLMES, MADORE,
STEFFL, STUMPF, THEOBALD

Assistant Professors:

BLEWETT, CHAFEY, CORLISS, ELLIS,
HUHNKE, KELLEY, LENDLE, McCLELLAN,
MURPHY, NACZKI, REIKE, SEHESTED,
SHOWALTER, WARREN, WEITZEL, WURZELL,
ZORNOW

Instructors:

CLEARY, STAPLETON, STENGEL, TICE

Bachelor of Science in Nursing Degree Curriculum. The candidate for a degree of Bachelor of Science in Nursing must complete 126 semester hours, including 40 hours in general studies, 40 hours in related non-nursing courses and electives, and 46 upper division credits in the nursing major. Required courses for the nursing major are: NU 301, 302, 311, 312, 401, 411, 412, and either 498 or 499.

NURSING

NU 301 Foundations of Nursing I. Knowledge of forces and resources within the community and their relationship to individuals in the community. Emphasis on the skills of inquiry, communication, observation, assessment and decision-making using the systems approach. Taken concurrently with NU 311.

Prerequisite: junior standing in the nursing major. Credit, 3 hours.

302 Foundations of Nursing II. Role of the professional person in nursing intervention. Emphasis on crisis intervention, teaching-learning and therapeutics for the acutely ill. Prerequisites: NU 301, 311. Credit, 3 hours.

311 Clinical Nursing I. Applies understanding of human development, human adaptation and activities of daily living to changing family patterns. Applies knowledge of the effect of environment on health in the community. Taken concurrently with NU 301. Prerequisite: junior standing in the nursing major. Four hours lecture, 4 hours conference, 9 hours laboratory. Credit, 9 hours.

312 Clinical Nursing II. Applies knowledge to give individualized nursing care to the acutely ill, short-term hospitalized patient of any age. Prerequisites: NU 301, 311. Two hours lecture, 4 hours conference, 12 hours laboratory. Credit, 8 hours.

401 Foundations of Nursing III. Role of the professional nurse as a collaborative member of the health team. Emphasis on the use of group process, research findings, community organizations and continuing education. Taken concurrently with NU 411. Prerequisites: NU 302, 312. Credit, 3 hours.

411 Clinical Nursing III. Applies knowledge to give individualized nursing care to the critically ill, long-term patient of any age whose illness creates a family crisis and has a community impact. Taken concurrently with NU 401. Prerequisites: NU 302, 312. Two hours lecture, 4 hours conference, 15 hours laboratory. Credit, 9 hours.

412 Clinical Nursing IV. Principles of organization and management in delivering individualized nursing care to groups of patients in the hospital and in the community. Taken concurrently with either NU 498 or 499. Prerequisites: NU 401, 411. Two hours lecture, 4 hours conference, 15 hours laboratory. Credit, 9 hours.

460 Recent Advances in Nursing. Advanced study and/or supervised practice in an area of nursing. Credit in different areas of study may be accumulated to 5 hours. Prerequisites: senior standing and/or approval of the instructor. Credit, 1-5 hours.

498 Pro-Seminar. Small group or individual study and library research related to a nursing problem. Prerequisites: senior standing and/or approval of the instructor. Credit, 2-3 hours.

499 Independent Study (Honors). Opportunity is provided the student to formulate and execute an independent study based on a nursing care problem. Prerequisites: NU 301, 302, 311, 312, 401, 411. Credit, 2-3 hours.

500 Research Methods I. Introduction to investigative methods. Purposes, aims of research. Review of research in nursing. Designed to assist in understanding and utilizing research concepts and methods. Credit, 2 hours, granted upon completion of NU 500 and NU 501.

501 Research Methods II. Research design. Role of theory, methods of data collection. Definition of study problem for individual projects. Credit, 2 hours, granted upon completion of NU 500 and NU 501.

580 Advanced Clinical Nursing I. Ecological approach to family competencies, dynamics and health. Related to health care in the community and the role of the nurse in a changing society. Practicum. Prerequisite: enrollment in nursing major and approval of instructor. Credit, 3 hours.

581 Advanced Clinical Nursing II. Critical examination of nursing theories. Crisis theories as base in nursing intervention in short- and long-term illness. Practicum. Prerequisite: enrollment in nursing major and approval of instructor. Credit, 3 hours.

591 Seminar. Credit 2-4 hours. Topics may be selected from the following:

(a) Advanced Physiology

(b) Special Problems in Human Development

(c) Suicidology

(d) Curriculum Development in Nursing

(e) Development of Nursing Theory

(f) Administration in Nursing

(g) The Supervisory Process

(h) Consultation in Nursing

(i) Current Developments

(j) Community Mental Health

(k) Group Dynamics

(l) Teaching in Nursing Programs

680 Advanced Clinical Nursing III. Advanced specialized clinical theory and practice. Sect. 1 — Family-Child Nursing. Sect. 2 — Community Mental Health-Psychiatric Nursing. Sect. 3 — Medical-Surgical Nursing. Prerequisite: approval of instructor. Credit, 4 hours.

681 Advanced Clinical Nursing IV. Advanced specialized clinical theory and practice. Includes area of special interest option. Sect. 1 — Family-Child Nursing, Sect. 2 — Community Mental Health-Psychiatric Nursing, Sect. 3 — Medical-Surgical Nursing. Prerequisite: approval of instructor. Credit, 4 hours.

Special graduate courses: 590, 592, 594, 680. (See pages 46-47.)

HUMAN DEVELOPMENT

HD 510 Human Development I. Biological, social, psychological development in infancy, childhood and adolescence. Developmental issues and theories, socialization processes, norms and deviations. Prenatal influences. Prerequisite: CD 232 or equivalent. Credit, 4 hours.

511 Human Development II. Developmental changes in early adulthood through later adulthood. Consideration of biological aspects, socialization, psychological influences, the aging process, retirement and leisure, life review and death. Prerequisite: approval of instructor. Credit, 3 hours.

College of Fine Arts

HENRY A. BRUINSMA, PH.D.

Dean

Purpose and Organization

The College of Fine Arts functions within the general framework and philosophy of the University. In addition to providing services and courses in the General Studies program of the University, the College provides thorough professional training for properly qualified students, supported by a broad background of courses designed to prepare the student for responsible citizenship.

The College, through its programs in art, dance, music, speech and theatre, and in the interdisciplinary humanities, reflects the wide range of challenges facing the communicative artist and scholar in the twentieth century. As an integral part of a University with strong supporting departments, the College provides each student the philosophical foundation for his art, strengthened by the other scientific, behavioral, and humanistic disciplines fundamental to the forming of the contemporary creative artist and scholar.

In addition to the curricula offered by each department of the College, close ties are maintained with the Colleges of Liberal Arts and Education through courses and curricula designed to meet the educational goals of those Colleges. The College of Fine Arts also enriches the life of the University community through its extension and laboratory offerings with an intensive series of art exhibitions, the operation of the University Art Gallery and the several art collections, concerts and recitals, dramatic productions, musical theatre, lectures, and various diagnostic and clinical services.

General Studies Program

To meet the General Studies requirement, students in the Bachelor of Arts and the Bachelor of Science degree programs must

take a minimum of 54 semester hours of credit in General Studies. Students in the Bachelor of Fine Arts and the Bachelor of Music degree programs must meet the University minimum requirement of 36 hours of credit in General Studies. At least 8 credit hours of course work must be taken in each of the fields of humanities and fine arts, social and behavioral sciences, sciences and mathematics. Courses in the field of specialization may not be used to meet the General Studies requirement, but courses included in related fields normally considered as part of the major may be included. Students are reminded of the University requirement in freshman English in addition to the above. See page 28 for complete description of the University General Studies program.

Special Programs

Honors Program. The Honors Program in the College of Fine Arts is intended for the outstandingly competent student whose interests and specific curriculum indicate that definite advantages may accrue from a program emphasizing individual study. For a general description of Honors work, see page 29 of this catalog.

Undergraduate Credit for Graduate Courses. To enable interested students to benefit as much as possible from their undergraduate studies, the Graduate College and the College of Fine Arts extend to seniors, with a grade point index of at least 2.50, the privilege of taking 500-level graduate courses for undergraduate credit with the approval of the instructor. Application for admission to a graduate course for undergraduate credit must be completed in advance of the regular registration period. The application must be approved by the advisor, the instructor of

the 500-level graduate course, and by the chairman of the department which offers the course.

Pre-Professional Programs. The College of Fine Arts offers, through its regular major degree programs, the opportunity to prepare for admission to graduate professional programs in law, medicine, dentistry and theology. For special advisement and assistance in developing a program of study consult with the Coordinator of Advisement in the College of Fine Arts office.

In addition, students preparing for admission to professional graduate schools should obtain information regarding admission requirements by writing directly to the schools in which they may be interested.

Special Secondary Education Program. A student majoring in the College of Fine Arts may obtain a baccalaureate degree and meet the requirements for a secondary education certificate. The student must meet all requirements established by the College of Education, including professional education courses and directed teaching, and all the College and departmental requirements for the major degree program in the College of Fine Arts. For information regarding the requirements of the College of Education, the student should consult the Department of Secondary Education.

Degrees

Bachelor's Degrees. The College of Fine Arts offers work leading to four bachelor's degrees: Bachelor of Arts, Bachelor of Science, Bachelor of Fine Arts, and Bachelor of Music. In general, the distinctions among these curricula lie in the degree of specialization permitted in the major field, with the

Bachelor of Arts degree providing a broader humanistic program, and the other three placing greater emphasis upon the major field while maintaining the principle of general studies required of all University students. In cooperation with the College of Education, each department of the College of Fine Arts also offers major and minor programs designed to provide teachers of art, music, speech, drama and humanities for the public schools.

Bachelor's degrees are offered in the following fields:

Bachelor of Arts:

- Art
- Art History
- Humanities (Interdisciplinary)
- Music
- Speech
- Theatre

Bachelor of Science:

- Art (Ceramics-Crafts, Commercial Art)
- Communication Disorders
- Speech Communication

Bachelor of Music:

- Music Performance
- Choral Music
- Instrumental Music
- Theory and Composition

Bachelor of Fine Arts:

- Ceramics-Crafts
- Commercial Art
- Dance
- Design
- Environmental Design
- Painting and Drawing
- Photography
- Printmaking
- Sculpture

Master's Degrees. A graduate program consisting of a minimum of 30 semester hours

of approved work leads to a master's degree in the following fields:

Master of Arts:

- Art Education
- Art History
- Humanities (Interdisciplinary)
- Music History and Literature
- Speech Communication
- Theatre

Master of Fine Arts:

- Ceramics
- Design
- Painting and Drawing
- Photography
- Printmaking
- Sculpture

Master of Music:

- Composition
- Conducting
- Music Theatre
- Pedagogy (Solo, Choral, Instrumental, General Music)
- Performance
- Theory

Master of Science:

- Audiology
- Speech Pathology

Master of Arts in Education (offered by the College of Education):

- Art Education
- Music Education
- Speech
- Theatre

Doctor of Education Degree:

In cooperation with the College of Education, the Department of Art and the Department of Music offer special curricula leading to the Doctor of Education degree with majors in Art Education or Music Education.

Bachelor of Arts Degree. The curriculum for the degree Bachelor of Arts is designed to give the student a broad, general background in the principal fields of human knowledge and a reasonable amount of specialized training in a selected area. This degree is offered in the Departments of Art, Music, Speech and Theatre, and also in the Center for the Humanities. At least 18 semester hours of credit in the major field must be in upper division courses. Of the total 126 credit hours required for graduation, at least 50 credit hours must consist of upper division courses.

MAJOR REQUIREMENTS. The major consists of approximately 45 semester hours of credit. Normally, not more than 30 semester hours will be taken in the field of specialization, and approximately 15 semester hours in one or more related fields. The exact content of the major is selected by the student in consultation with the advisor under the rules and regulations of the department concerned.

GENERAL STUDIES REQUIREMENTS. Fifty-four semester hours of the total 126 required for graduation must be in General Studies. In the field of sciences and mathematics, the student must elect at least one course in a laboratory science.

ADDITIONAL DEGREE REQUIREMENTS.

1. Knowledge in one foreign language equivalent to the level obtained through 16 hours of instruction in elementary and intermediate courses on the college level. This requirement may be fulfilled in whole or in part through language instruction in secondary schools or by other means. If acquired in secondary school, two years of instruction in one foreign language will be considered the equivalent of one year of instruction on the college level. Students who

transfer from other colleges with less than two years of credit in a foreign language will be placed in a course at the next level above the work completed.

2. A cumulative scholarship index of 2.00 is required for graduation and no credit will be granted toward fulfilling major requirements in any upper division course in the student's major unless the grade in that course is at least a "C." (See exception to this grade point requirement in the Humanities major program.)

Bachelor of Science Degree. The curriculum for the degree Bachelor of Science is designed to give the student a broad, general background in the principal fields of human knowledge and an opportunity to specialize in one specific selected area. This degree is offered with majors in Art, Communication Disorders and Speech Communication. Of the total 126 credit hours required for graduation, at least 50 credit hours must consist of upper division courses.

MAJOR REQUIREMENTS. The major consists of from 45 to 55 semester hours of credit. The content of the major is selected by the student in consultation with the advisor under the rules and regulations of the department concerned.

GENERAL STUDIES REQUIREMENTS. Fifty-four semester hours of the total 126 required for graduation must be in General Studies. In the field of sciences and mathematics, the student must elect at least one course in the physical sciences, one course in the life sciences, and one course in mathematics. One of these courses must be a laboratory science.

ADDITIONAL DEGREE REQUIREMENT. A cumulative scholarship index of 2.00 is required for graduation and no credit will be granted toward fulfilling major requirements

in any upper division course in the student's major unless the grade in that course is at least a "C." (See exception to this requirement in the Communication Disorders major program).

Bachelor of Fine Arts Degree. The curriculum for the degree Bachelor of Fine Arts is designed to meet the needs of the student with specific professional interest in creative performance in a specialized field of the arts, while providing him with a broad, general background in the principal fields of human knowledge. This degree is offered in the Department of Art, and is also available with a major in Dance through the Department of Health, Physical Education and Recreation. Students enrolled in the Dance major will register in the College of Fine Arts. Of the minimum 126 credit hours required for graduation, at least 50 credit hours must consist of upper division courses.

MAJOR REQUIREMENTS.

1. A major in one of the areas of Art consists of 76 semester hours of credit, divided between the core curriculum and the area of specialization.

a) The level of courses in the core curriculum will be determined by the advisor in consultation with the student and will be based upon the student's aptitudes, needs, and previous level of training. The core curriculum shall include the following areas of study:

	<i>Semester Hours</i>
Basic Design	6
Drawing	6
Painting	3
Sculpture	3
Ceramics or Crafts	3
Art History	12
Total	33

b) The area of specialization shall be determined by the student on the basis of his interests and professional intentions and, in addition to the core program above, shall consist of 43 hours of course work selected by the student in consultation with his advisor. A minimum of 12 credit hours of courses numbered 300 or 400 in one specific creative field must be included within the area of specialization. The student, in consultation with his advisor, may select applicable courses from other departments or colleges when it is felt they will make a specific contribution to his program of study. The following areas of specialization are available to the student: Painting, sculpture, printmaking, design, ceramics-crafts, commercial art, environmental design, photography.

2. A major in Dance consists of a minimum of 70 semester hours of course work in Dance and related fields. See page 82 for detailed requirements.

GENERAL STUDIES REQUIREMENTS. Thirty-six semester hours of the minimum 126 required for graduation must be in General Studies. In the field of sciences and mathematics the student must take at least one course in a laboratory science.

ADDITIONAL DEGREE REQUIREMENTS. A cumulative scholarship index of 2.00 is required for graduation and no credit will be granted toward fulfilling major requirements in any upper division course in the student's major unless the grade in that course is at least a "C."

Bachelor of Music Degree. The curriculum for the degree Bachelor of Music is designed to give the student a broad general background in the principal fields of knowledge and training of a professional caliber in

music performance, music theory, composition, church music, and the teaching of choral and instrumental music. Of the minimum 126 credit hours required for graduation, at least 50 credit hours must consist of upper division courses.

Placement tests in theory, piano and a major performing medium are required of all freshman and transfer students.

MAJOR REQUIREMENTS. The major consists of 84 semester hours of credit in music. The content of the major is selected by the student in consultation with the advisor under the rules and regulations of the Department of Music.

GENERAL STUDIES REQUIREMENTS. Thirty-six semester hours of the 126 required for graduation must be in General Studies.

ADDITIONAL DEGREE REQUIREMENTS.

1. The foreign language requirements vary with the student's major program leading to the Bachelor of Music degree.

- a) Choral and instrumental music: no foreign language requirement.
- b) Music performance: *Voice majors* — 16 hours of credit in more than one foreign language, chosen from French, German, or Italian. A student may elect one year of one language, and either one or two semesters of the other(s), chosen in conference with his advisor.

Instrumental majors — 16 hours of credit in one or two foreign languages.

- c) Music theory, composition: 8 hours of credit in one foreign language.

The requirement of knowledge in one foreign language equivalent to the level obtained through 16 hours of instruction in elementary and intermediate courses on the college level may be fulfilled in

whole or in part through language instruction in secondary school. Two years of instruction in one language will be considered the equivalent of one year of instruction on the college level. Students who transfer from other colleges with less than two years of credit in a foreign language will be placed in a course at the next level above the work completed.

2. A cumulative scholarship index of 2.00 is required for graduation and no credit will be granted toward fulfilling major requirements in any upper division course in the student's major unless the grade in that course is at least a "C."

3. All students majoring in music are required to attend the weekly studio class or recital as listed in the *Time Schedule*. In addition, attendance at five major University programs each semester is required.

The Department of Music is a member of the National Association of Schools of Music, and the requirements for entrance and graduation set forth in this catalog are in accordance with the published regulations of that Association.

Art

Professors:

LINDERMAN (ART 102), BROADLEY, FINK,
GOO, HARTER, JACOBSON, SCHAUMBURG,
TAYLOR, WOOD

Associate Professors:

BRECKENRIDGE, GRIGSBY, HALE,
TURK, WAGNER

Assistant Professors:

BERSHAD, FARNES, GIBBS, HAHN,
SCHRIEBER, STERLING, STULER,
WOODS, BROUCH

Instructors:

KRONENGOLD, SCHMIDT, SHIPP,
ZIMMERMAN

Departmental Major Requirements

For advisement purposes, all students registering in an art major program will enroll through the College of Fine Arts.

Bachelor of Arts Degree Curriculum:

ART — Consists of 45 semester hours of credit, with a concentration in one area of specialization, with at least 15 hours in closely related fields to be approved by the advisor in consultation with the student. Courses AR 111, 141, 142, 223; AH 101, 102 are required. At least 18 semester hours must be in upper division courses.

ART HISTORY — Consists of 45 semester hours of credit, no less than 27 of which shall be in Art History. At least 18 hours in Art History must be in upper division courses. The areas, Ancient, Medieval, Renaissance and Modern, must each be represented with at least one course. A minimum of 18 hours shall

be in approved related fields. Satisfactory completion of AA 456 Methodology and Bibliography is required of Art History majors before the senior year. Required courses are AH 101 and 102; AA 456; AR 111 and 141 with at least one additional course chosen from AR 114, 131, 223 and 351.

Bachelor of Science Degree Curriculum:

ART — Consists of 50 semester hours of credit, with a concentration in one area of specialization to be approved by the advisor in consultation with the student. Courses AR 111, 114, 141, 223; AH 101, 102 are required. At least 20 semester hours must be in upper division courses.

Bachelor of Fine Arts Degree Curriculum:

ART — Consists of 76 semester hours of credit, with a concentration in one area of specialization to be approved by the advisor in consultation with the student. Courses AR 111, 114, 223, 131, 141, 142, 161, or 271; AH 101, 102 are required. At least 30 semester hours must be in upper division courses.

Departmental Major Teaching Field Requirements**Bachelor of Arts in Education Degree Curriculum:**

ART — Consists of 60 semester hours of credit in art. Courses AR 111, 114, 141, 142, 223, 131 and 161; AH 101, 102; AE 301, 412 and 480 are required. Additional hours to complete the major will be approved by the advisor in consultation with the student. At least 18 semester hours must be in upper division courses one of which must be in Art History.

Departmental Minor Teaching Field Requirements

Elementary Education Major. Consists of 24 semester hours including AR 141, AE 301, AE 420 which are required. The remaining of 15 semester hours are to be selected in consultation with an art education advisor.

Secondary Education Major. Consists of 24 semester hours including AR 141, AE 480 which are required. The remaining 18 semester hours may be selected in consultation with an art education advisor.

Secondary Education Major, Minor in Photography. Consists of 24 semester hours including AR 141, 191, 291, 391, 491 (black/white), 491 (color), 499; and AE 480.

Departmental Graduate Programs

The Department of Art offers programs leading to the degrees of Master of Arts, Master of Fine Arts, Master of Education with major in Art Education, Doctor of Education in Art Education. Consult the *Graduate Catalog* for requirements.

A R T**ADVERTISING DESIGN**

AR 181 Advertising Design. A studio survey of six major graphic advertising media. One comprehensive design problem in each. Six hours a week. Credit, 3 hours.

182 Beginning Lettering. Design, construction and spacing of basic Gothic, Roman and Italic alphabets. Exercise in design and arrangement in relation to space. Collection and classification of lettering and type proofs. Six hours a week. Credit, 3 hours.

281 Fundamentals of Graphic Design.

Exercises in technique; systematic intellectual approach to graphic design. Practical study of the elements involved in the effective use of typography. Emphasis on the sequential nature of graphic design: problems of rhythm, interval, pattern, texture and shape. Prerequisites: AR 141, 181 or approval of instructor. Six hours a week. Credit, 3 hours.

282 Intermediate Lettering. Basic letter forms and their relation to type design and typographic practice. Sensitivity to letter design developed through writing and broad-nib pens leading to built-up letters. Problems in page design. Prerequisites: AR 141, 142, 181 or approval of instructor. Six hours a week. Credit, 3 hours.

381 Graphic Design. Further exploration of the communicative potential of visual images. Use of various media and techniques in their development as related to technological limitations of production. Emphasis on typography. Prerequisites: AR 281, 282. Six hours a week. Credit, 3 hours.

382 Advanced Lettering. Concentrated problems in the use of letters as positive elements in design. Study and practice of the written italic form. Prerequisite: AR 282. Six hours a week. Credit, 3 hours.

383 Graphic Illustration. Rough and comprehensive black and white and limited color illustrations. Relation of illustration to type and other elements in brochures, books. Prerequisites: AR 141, 142, 181. Six hours a week. Credit, 3 hours.

481 Techniques of Advertising Production. Preparation of finished art and mechanicals for reproduction by offset lithography or letterpress printing. Preparation of a professional portfolio. This course is coordinated with GA 438 which must be taken the same semester. May be repeated for credit. Prerequisite: AR 383. Six hours a week. Credit, 3 hours.

CERAMICS

AR 161 Beginning Ceramics. The nature of clay and glazes, handforming methods, throwing on the wheel, decorative processes, glaze application. Prerequisite for art majors: AR 141. Six hours a week. Credit, 3 hours.

261 Intermediate Ceramics. Continuation of AR 161 with a concentration of potter's wheel techniques and further development of decorative processes and glaze applications. Prerequisite: AR 161. Six hours a week. Credit, 3 hours.

361 Advanced Ceramics I. Continued studio problems with an emphasis on hand-forming methods. Experimental work in clay and glaze formulation. Practical problems in kiln firing. Prerequisites: AR 141, 261. Six hours a week. Credit, 3 hours.

362 Advanced Ceramics II. Emphasis on glaze formulation with experimentation in use of ceramic glaze materials and colorants. Prerequisite: AR 361. Six hours a week. Credit, 3 hours.

461 Problems of Ceramics. Studio problems adapted to meet individual needs. Advanced research for the individual potter and teacher. Prerequisite: AR 361 or equivalent. Six hours a week. Credit, 3 hours.

CRAFTS

AR 172 Beginning Jewelry. Fundamentals of jewelry making. Covers hand-formed methods, including cutting, shaping, forging, soldering, as well as lost wax casting techniques. Six hours a week. Credit, 3 hours.

271 Introduction to Crafts. An exploratory approach to the design and production of contemporary crafts. Six hours a week. Credit, 3 hours.

371 Textiles. The development of a personal approach to textile design, utilizing processes such as batik, macramé, hooking. Six hours a week. Credit, 3 hours.

471 Advanced Jewelry. The development of a personal approach to jewelry design. Six hours a week. Credit, 3 hours.

472 Advanced Crafts. Includes creative work in all craft media. Six hours a week. Credit, 3 hours.

DESIGN

AR 141 Basic Design I. Fundamental experiences in graphic and spatial relationships. Development of perceptual, imaginative and expressive responses through problem solving and critical evaluation. Exploration of figure-ground relationships, skeletal structures, tonal values, color and surface manipulations. Six hours a week. Credit, 3 hours.

142 Basic Design II. Continued development of intellectual and intuitive responses to form and space. Interrelationship of design, man and the environment. Intensifying sensitivity of expression to form a personal standard of esthetic judgment. Prerequisite: AR 141. Six hours a week. Credit, 3 hours.

143 Interior Design. Introduction to the principles and concepts of environmental design. Historical and theoretical procedures of interiors and the relation to the environment in general. Six hours a week. Credit, 3 hours.

241 Space Design. Development of functional and esthetic structures with a variety of methods and materials. Emphasis will be on the articulation and analysis of volume and space relationships. Visionary constructions. Prerequisite: AR 142. Six hours a week. Credit, 3 hours.

243 Design Communication. Visual and verbal communication of ideas and techniques used in presentations. Exploration of design processes, methods and systems; architectural drawing. Six hours a week. Credit, 3 hours.

341 Intermediate Space Design. Exploration and experimentation of structural forms, shelters and interior detailing. Knowledge of systems design. Power tool operation and fabrication techniques. Model construction.

Prerequisites: AR 241 and 243. Six hours a week. Credit, 3 hours.

343 Advanced Interior Design. Principles and techniques of planning, methods of research and business procedures. Emphasis on the integration of form, light, color, texture, interior materials and components. Prerequisites: AR 143 and 243. Six hours a week. Credit, 3 hours.

344 Environmental Design. Experiments in acoustic, optical, tactile and color illusions for the development of total atmospheres. The interrelationship of esthetic, functional and psychological factors in the shaping of man-made environments. Prerequisite: AR 241. Six hours a week. Credit, 3 hours.

441 Advanced Space Design. Solving functional problems in the modulation of space. Research and evaluation of interior components used today and the speculative trends of the future. Design and construction of furniture. Prerequisite: AR 341. Six hours a week. Credit, 3 hours.

444 Advanced Environmental Design. Development and evaluation of sympathetic, esthetic responses. Research, documentation, design problems and presentations relating to physical, social and cultural environments of contemporary society. Prerequisite: AR 344. Credit, 3 hours.

489 Professional Workshop. Analysis of professional environments. Design and construction of an actual environment. Design portfolio preparation. Prerequisites: AR 441, 444. Six hours a week. Credit, 3 hours.

DRAWING

AR 111 Beginning Drawing. Study and practice of common drawing media and their application to current systems of pictorial organization. Directed toward the student with no previous college level art experience. Six hours a week. Credit, 3 hours.

114 Beginning Life Drawing. Development of skill and expressiveness in drawing the basic

form, construction and gesture from the human figure. Prerequisite: AR 111. Six hours a week. Credit, 3 hours.

211 Intermediate Drawing. Emphasis on composition; exploration of drawing media. Prerequisite: AR 111. Six hours a week. Credit, 3 hours.

214 Intermediate Life Drawing. Continuation of objectives of AR 114. Six hours a week. Credit, 3 hours.

311 Advanced Drawing. Continuation of AR 211. Prerequisite: AR 211. Six hours a week. Credit, 3 hours.

314 Advanced Life Drawing. Emphasizes various media and techniques on an advanced level, with additional outside requirements such as analysis of style, and anatomical structure. Prerequisites: AR 114, 214. Six hours laboratory, 2 hours outside preparation. Credit, 3 hours.

411 Drawing Techniques of the Old Masters. Historical techniques of drawing from early Renaissance to the present. The making and use of materials and tools including silver point, bistre ink, quill pen, pastels and chiaroscuro drawings, as used by Michelangelo, Rembrandt, Tiepolo and other masters. Prerequisite: approval of instructor. Six hours a week. Credit, 3 hours.

414 Advanced Life Drawing. Continuation of objectives of AR 314. Prerequisite: AR 314. Six hours a week. Credit, 3 hours.

PAINTING

AR 223 Beginning Painting. Composition, color and technical mastery of painting media. Prerequisites: AR 111, 114, 141. Six hours a week. Credit, 3 hours.

323 Intermediate Painting. Advanced problems in painting. Prerequisite: AR 223. Six hours a week. Credit, 3 hours.

421 Painting Mediums and Techniques. Designed to acquaint the student with materials and all varieties of painting. Experimental

problems in traditional and modern synthetic media. Six hours a week. Credit, 3 hours. (Section M) — A combination studio and lecture course emphasizing the unique character of mural painting in its essential relation to architecture. Two hours lecture, 4 hours laboratory. Credit, 3 hours.

423 Advanced Painting. Problems for those with a serious interest in painting. Prerequisite: AR 323. Six hours a week. Credit, 3 hours.

425 Figure Painting. Portrait and figure painting from model. Prerequisites: AR 314, 323. Six hours a week. Credit, 3 hours.

PHOTOGRAPHY

AR 191 Beginning Photographic Art. Photography as an art medium. Two lectures, 3 hours laboratory. Credit, 3 hours.

192 Introduction to Cinematography. An exploratory laboratory course into the basic aspects of film making as an art form. Emphasis on cinematic techniques in relation to basic art foundations and their relation to creative products. Prerequisite: AR 191. One lecture, 6 hours laboratory. Credit, 3 hours.

291 Intermediate Photographic Art. Development of the disciplines and attitudes of the creative artist-photographer. Prerequisite: AR 191. One lecture, 6 hours laboratory. Credit, 3 hours.

391 Advanced Photography. Interpretation and manipulation of light as a tool in the performance of expressive photography. Prerequisite: AR 291. One lecture, 6 hours laboratory. Credit, 3 hours.

491 Black and White Photography. (Section B) — Advanced exploration of experimental, interpretive, and straight photography. May be repeated for credit. Prerequisite: AR 391. One lecture, 6 hours laboratory. Credit, 3 hours.

492 Color Photography. (Section C) — Study and application of color photography and

printing processes to photographic art. May be repeated for credit. Prerequisite: AR 391. One lecture, 6 hours laboratory. Credit, 3 hours.

PRINTMAKING

AR 351 Intaglio-Printmaking. Process using etching, engraving, aqua-tint and other incising techniques. Prerequisite: approval of instructor. Six hours a week. Credit, 3 hours.

352 Lithography-Printmaking. Process using stone, plates, and incorporating drawings, transfer, photo-transfer and color techniques. Prerequisite: Approval of instructor. Six hours a week. Credit, 3 hours.

353 Relief-Printmaking. Process using wood, masonite, color and other relief techniques. Prerequisite: Approval of instructor. Six hours a week. Credit, 3 hours.

354 Serigraphy-Printmaking. Process using silk screen. Various methods and applications are used including the photographic, stencil and transfer techniques. Prerequisite: Approval of instructor. Six hours a week. Credit, 3 hours.

451 Advanced Intaglio-Printmaking. Continuation of AR 351. Prerequisite: Approval of instructor. Six hours a week. Credit, 3 hours.

452 Advanced Lithography-Printmaking. Continuation of AR 352. Prerequisite: Approval of instructor. Six hours a week. Credit, 3 hours.

453 Advanced Relief-Printmaking. Continuation of AR 353. Prerequisite: Approval of instructor. Six hours a week. Credit, 3 hours.

454 Advanced Serigraphy-Printmaking. Continuation of AR 354. Prerequisite: Approval of instructor. Six hours a week. Credit, 3 hours.

SCULPTURE

AR 131 Beginning Sculpture. Exploration and expression of sculptural form through ideas and concepts as related to basic materials. Emphasis on form relationships, volume, movement and space. Introduction to the means of sculpture and studio safety. Pre-

requisites: AR 111 and 141. Six hours a week. Credit, 3 hours.

231 Intermediate Sculpture. Continued search for form and personal expression through all media with emphasis on design and individual instruction. Introduction of welding and brazing techniques and casting in aluminum and bronze. (Section E: Experimental. Experimentation in nontraditional approach, fabrication, structure, through synthetic or natural materials in sculpture. Emphasis on the nature of the exploratory process in search for a personal expression). Prerequisite: AR 131. Six hours a week. Credit, 3 hours.

331 Advanced Sculpture. Introduction of sculptural problems related to architecture and man's environment. Exploration in all media and introduction to color relationships as applied to sculpture. (Section E: Experimental). Prerequisite: AR 231. Six hours a week. Credit, 3 hours.

431 Special Problems in Sculpture. Development of a personal approach to sculpture, emphasis on form, individual problems and related color technology. Introduction to professional practices and presentation. Prerequisite: AR 331. Six hours a week. May be repeated for credit. Credit, 3 hours.

432 Experimental Sculpture. Analysis in non-traditional approach, fabrication and structure, through synthetic and natural materials in sculpture. Emphasis is placed on the nature of the exploratory process in the search for a personal expression. Prerequisite: AR 231 or approval of instructor. Six hours a week. Credit, 3 hours.

WATERCOLOR

AR 222 Beginning Watercolor. Painting in all water-soluble media. Emphasis on techniques, composition and color. Prerequisite: AR 111. Six hours a week. Credit, 3 hours.

322 Intermediate Watercolor. Explorations using a variety of surfaces, a combination of media and materials in a continued search

for creative form. Prerequisite: AR 222. Six hours a week. Credit, 3 hours.

422 Advanced Watercolor. Experimentation toward a more personal expression. Prerequisite: AR 322. Six hours a week. Credit, 3 hours.

SPECIAL COURSES

AR 521 Studio Problems and Techniques. Advanced study in the fields of ceramics, crafts, design, drawing, painting, photography, printmaking and sculpture. Six hours a week. May be repeated for credit. Credit, 3 hours.

580 Creative Terminal Project. Must be done in one of the six major areas of concentration in the MFA degree program. Must be approved by the student's committee before undertaken, and before completion the student must submit a complete written and documented report. A public exhibition approved by the student's committee must precede the final examination. Selected materials from the exhibit may be retained by the University on indefinite loan. Credit, 10-15 hours.

ART EDUCATION

AE 301, 302 Art in the Elementary School. Emphasis on self-understanding through the use of art, concurrent with the study of the art work of children of all ages from early childhood to mid-adolescence. One lecture, 4 hours laboratory. Credit, 3 hours each semester.

412 Art Curriculum and Supervision. Exploration of theory, materials, organization, methods and curriculum for the art educator or consultant; the art educator's responsibility in human relations and communications. Required of all art education majors. Prerequisite: AE 480 or concurrently. Credit, 3 hours.

420 Crafts for the Elementary School Teacher. Practical laboratory experiences stressing inexpensive and salvage materials that children can use. Combinations of

materials and specific knowledges in mosaic, papier-mache, clay, wood, wire, etc. One lecture, 4 hours laboratory. Credit, 3 hours.

480 Art in the High School. Explorations of materials, theory and organization for presenting art activities and developments in the arts on the secondary level. Required of all art education majors. Prerequisites: AE 301, SE 311 or concurrently. One lecture, 4 hours laboratory. Credit, 3 hours.

511 History of Art Education. Historical and theoretical analysis of contemporary trends in American art education. Credit, 3 hours.

515 Foundations of Art Education. Analysis of behavioral foundations of education as related to art education. Emphasis on psychological and philosophical frame-of-reference. Credit, 3 hours.

520 Creativity in Art Education. Research into the nature of creative behavior especially as it applies to the visual arts. Information about creativity and its relation to student growth and performance for contemporary teaching. Credit, 3 hours.

525 Art and Society. Inter-relationship of art and society and significance of art education in social change. Emphasis on art as a cultural communication system and its relationship to urban renewal, the socially deprived, increased leisure, effects of automation. Credit, 3 hours.

530 Research in Art Education. An overview of recent research in art education. A critical examination of research methodology and implications for practice. Credit, 3 hours.

610 Issues and Trends in Art Education. Recent problems and directions in contemporary art education. Credit, 3 hours.

611 Curriculum Development in Art Education. Development of curriculum in terms of philosophical, psychological and sociological foundations. Relationship of objectives to practice. Credit, 3 hours.

Special Graduate Courses: 590, 591, 592, 690, 691, 692, 790, 791, 792.

ART HISTORY

AH 101 History of Art from the Dawn of Civilization to the Renaissance. A survey of ancient Near Eastern, Egyptian, Greek, Roman and medieval European art to the Renaissance. Credit, 3 hours.

102 History of Art from Renaissance to the Present Day. A survey of occidental art during the Renaissance, mannerist, baroque, rococo, neo-classic, romantic, and modern epochs. Credit, 3 hours.

103 Introduction to Oriental Art. A survey of sculpture, painting and architecture of Asia. Credit, 3 hours.

300 Introduction to Art. Development of understanding and enjoyment of art and its relationship to everyday life through the study of painting, sculpture, architecture and design. For nonart majors and minors only. Credit, 3 hours.

400 American Art I. History of art in the United States from European settlement of the New World to the Columbian Exposition of 1893. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

401 American Art II. History of art in the United States from the last decade of the 19th century. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

402 Mexican Art. Art of Mexico and related Central American cultures from the prehistoric to the contemporary schools. Prerequisites: AH 101 and 102 or permission of instructor. Credit, 3 hours.

403 Primitive Art. Art forms and expression of paleolithic, neolithic and early metal age cultures from prehistory to the present. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

404 African Art. Art forms of West and Central Africa from prehistoric times to the present. Sculpture, architecture and crafts are considered in relation to societies which produced them, and their influence on other

cultures. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

405 Southwest Indian Art. Arts and crafts of the southwestern American Indians from prehistoric times as related to their historical background and social customs. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

406 Oriental Art I. Painting, sculpture and architecture of India and Southeast Asia. Prerequisites: AH 103, or 101 and 102, or approval of instructor. Credit, 3 hours.

407 Oriental Art II. Arts of China, Korea and Japan. Prerequisites: AH 103 or 406 or approval of instructor. Credit, 3 hours.

410 Ancient Art I. History of paintings, sculpture and architecture in Mesopotamia, Egypt, the Aegean and Greece. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

411 Ancient Art II. History of Roman, Early Christian and Byzantine art. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

412 Early Medieval Art. Arts of western Europe during the Barbarian, Carolingian, Ottonian and Romanesque epochs. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

413 Late Medieval Art. Painting, sculpture and architecture in western Europe during the Gothic period. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

414 Renaissance Art in Northern Europe. History of painting, sculpture and architecture north of the Alps in the 15th and 16th centuries. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

415 Early Renaissance Art in Italy. History of painting, sculpture and architecture in Italy from 1300 to 1500. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

416 Art of the High Renaissance and Man-

nerism. History of art during the 16th century with special consideration of the achievements and influence of Leonardo da Vinci, Raphael and Michelangelo. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

417 Art of the 17th Century. History of baroque art in its varied aspects from 1600 to 1700. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

418 Art of the 18th Century. History of European painting, sculpture and architecture between 1700 and 1800 with emphasis on the rococo. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

419 Art of the 19th Century. Major trends and movements in the history of western art between 1800 and 1900. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

420 Art of the 20th Century. Developments and directions in art since 1900. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

421 Contemporary Art. Recent and current trends in art with special consideration of new concepts and experimentation with media and modes of presentation. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

422 History of Printmaking. History of the print as an art form and its relation to other modes and forms of artistic expression. Prerequisites: AH 101 and 102 or approval of instructor. Credit, 3 hours.

591 Seminar. Credit, 3 hours. Topics selected from the following:

- (a) Problems in Oriental Art
- (b) Problems in Ancient Art
- (c) Problems in Medieval Art
- (d) Problems in Renaissance Art
- (e) Problems in Baroque Art
- (f) Problems in Modern Art
- (g) Problems in Mexican Art

AUXILIARY COURSES

AA 450, 451 Structure, Expressiveness and Symbolism of Art. The mature appreciation and understanding of the arts, emphasizing the relationships of art, music, philosophy and literature. Intended to integrate and give meaning to studio skills for majors in art or music, and to teachers and all who wish to increase understanding of modern arts. Prerequisite: approval of instructor. Credit, 3 hours each semester.

452 Museology I. History of art collecting, connoisseurship and techniques of conservation and restoration. Prerequisite: approval of instructor. Credit, 3 hours.

454 Museology II. Exhibition planning, methods of recording and cataloging works of art, administration and organization of art museums. Prerequisite: approval of instructor. Credit, 3 hours.

456 Methodology and Bibliography. Materials and methods of art historical research. Credit, 3 hours.

Special Graduate Courses: 590, 591, 593, 690, 691, 693. (See page 46.)

HUMANITIES (Center for the Humanities)

Professor:

LAMM (NORTH HALL 15½)

Associate Professors:

BRECKENRIDGE, STELLHORN, TURK

Assistant Professor:

MEYER

Instructors:

HANSEN, HORWITCH

Major Requirements

Bachelor of Arts Degree Curriculum. The Interdisciplinary Humanities program con-

sists of 45 semester hours of credit in the four subject fields of art and architecture, literature, music and philosophy, plus a core of 28 semester hours in Interdisciplinary Humanities and Comparative Arts courses. Three of the four fields must be chosen and semester hours accumulated in the following pattern: first subject, 20-21 hours; second subject, 15 hours; third subject, 9-12 hours. Approved courses, specific Interdisciplinary Humanities and Comparative Arts courses and suggested elective courses are selected in consultation with the advisor. Minimum grade point index for retention in the program: 0-29 hours, 2.00; 30-59 hours, 2.25; 60-89 hours, 2.50; 90 hours or more, 2.75.

Minor Requirements

A 24-semester-hour teaching minor in Humanities in Secondary Education (Bachelor of Arts in Education) is offered in cooperation with the College of Education. This program normally includes HU 101, 102; HU 301, 302; two courses selected from HU 403, 404, 405 and 406; two hours of electives. An acceptable alternative program consists of HU 101, 102 *or* HU 301, 302; HU 403, 404, 405, 406 and four hours of electives. Electives may include applied, studio, technical and laboratory work in the arts and humanities but may not include courses in the teaching major.

Graduate Program

Consult the *Graduate Catalog* for requirements in the Interdisciplinary Humanities program leading to the degree of Master of Arts.

☉ HUMANITIES

HU 101, 102 Ideas and Values in the Human-

ities. Interrelation of art and architecture, literature, music and philosophy in the modern world. Term paper and attendance at selected cultural events required. Credit to meet the General Studies requirement in the Humanities given only when both HU 101 and 102 are taken. Class registration open to freshmen only. Credit, 4 hours each semester.

301, 302 Humanities in the Western World. An integrated course designed to develop a discriminating appreciation of art and architecture, literature, music and philosophy. The heritage of the past is presented in relation to life today. Term paper and attendance at selected cultural events required. Credit for General Studies given only when both HU 301 and 302 are taken. Credit, 4 hours each semester.

401 Humanities in World Cultures. A humanities study program of foreign travel. Emphasis on the study of the fine arts of the various world cultures. Art galleries, museums, drama and music festivals form a basic part of the itinerary. Term paper required. May be repeated for credit. Prerequisite: approval of instructor. Credit, 6 hours.

402 Technology, Society and Human Values. Examination of those values which motivate mankind to create technology. Areas of conflict and resolution between basic human values and technological society. Reading and discussion with visiting discussion leaders. Prerequisite: junior standing or permission of instructor. Credit, 3 hours. (Also listed under 4ES 402.)

403, 404 Comparative Arts I, II. Art and architecture, literature, music and the minor arts against a background of socio-economic development and philosophic thought. First semester, Greece through Early Christian and Byzantine; second semester, Romanesque through Renaissance. May be taken concurrently with HU 405, 406. Prerequisites: HU 301, 302 or approval of instructor. Credit, 3 hours each semester.

405, 406 Comparative Arts III, IV. Art and

architecture, literature, music and the minor arts against a background of socio-economic development and philosophic thought. First semester, baroque through 19th century; second semester, 20th century. May be taken concurrently with HU 403, 404. Prerequisites: HU 301, 302 or approval of instructor. Credit, 3 hours each semester.

498 Pro-Seminar in Comparative Arts. Credit, 3 hours. Prerequisite: approval of instructor. Cultural periods may be selected from the following:

- (a) The Ancient Middle East
- (b) Graeco-Roman
- (c) Early Christian and Byzantine
- (d) Romanesque
- (e) Gothic
- (f) Renaissance
- (g) Mannerism and Baroque
- (h) Rococo and Neo-Classical
- (i) 19th Century
- (j) 20th Century
- (k) Humanities in the Eastern World

532 Humanities Bibliography. Investigations of the important primary and secondary sources of research in humanities and humanities education. Credit, 3 hours.

601 Philosophical Foundations of Humanities Education. Basic issues in intellectual traditions of the western world which are foundational to the philosophies of humanities education. Credit, 3 hours.

602 Experimentation and Recent Trends in Humanities Education. A critical analysis and evaluation of current and in-process developments in humanities education. Credit, 3 hours.

603 Curriculum Development in Humanities Education. Issues, patterns and procedures in humanities curricula. Credit, 3 hours.

Additional courses are listed under Music, Philosophy, Art, Architecture and Literature (English).

Special Graduate Courses: 500, 590, 591, 592, 593, 594, 690, 691, 692 (see page 46).

MUSIC

Professors:

BROEKEMA (Mus. 405), BRUINSMA, BULLOCK, ENGLISH, FLETCHER, JOHNSON, LAMM, LOMBARDI, SCOLAR, SEIPP, SNAPP, STELLHORN

Associate Professors:

BOWERS, BRITTON, CARROLL, COHEN, DALES, DRESSKELL, HANNA, HEFFERNAN, HINES, ISAAK, KEATING, LoPRESTI, McEWEN, PUTNIK, REYNOLDS, RICKEL, ROBINSON, SPINOSA, STALZER

Assistant Professors:

ATSUMI, DEMAND, MILLER, RATTERREE, RAUSCH, RAVE, MARGO SMITH, MARION SMITH

Instructors:

BLOEMENDAAL, HANSEN, WALTERS

Departmental Major Requirements

For advisement purposes, all students registering in a music major program will enroll through the College of Fine Arts.

Bachelor of Arts Degree Curriculum:

Music — Consists of 45 semester hours of credit. The following courses are required: Music Theory — MU 125, 320, 322, 427 and three courses selected from MU 220, 221, 222 and 223

Music History and Literature — MU 241 and 242

Major Performing Medium — 8 semester hours (MP 111/311)

Class Piano — MP 131, 132, 231, 232 (unless waived by proficiency examination)

The remaining hours in music will be selected by the student in consultation with his advisor. At least 18 semester hours must be in upper division credit. A minimum of 126 hours is required for graduation.

Bachelor of Music Degree Curriculum. Consists of 84 semester hours of credit. This curriculum offers fields of specialization in choral music, instrumental music, music performance, and theory and composition. Choral and instrumental majors are provided for students wishing to meet certification requirements for teaching in the public schools. All fields of specialization within the Bachelor of Music curriculum require the following basic core:

Music Theory – MU 125, 322, 427, and three courses selected from MU 220, 221, 222 and 223

Music History and Literature – MU 241, 242

Conducting – MP 209 and 339 or 340

Major Performing Medium – 8 semesters of study (Note: 4 semesters for the theory and composition major may be for instruments other than the major performing medium.)

Ensemble – 8 semesters of participation.

Class Piano – MP 131, 132, 231, 232 (unless waived by proficiency examination).

Additional music requirements for each field of specialization are as follows:

MAJOR IN CHORAL OR INSTRUMENTAL MUSIC
(Note: This degree program includes a teaching major in one field and a minor in the other.)

Music Theory – MU 431 and 433

Music Education – ME 480, 483, and 313 or 315

Conducting – MP 339/340

Class Voice – MP 133, 134, 233 and 234 (required of those whose major performing medium is not voice.)

Class Instruments – ME 325, 326, 327, 328, 336, 337 and 338.

(Note: Only 325, 327, 336 and 337 are required of choral majors.)

Ensemble – 2 semesters of a minor teaching field ensemble.

MAJOR IN PERFORMANCE (KEYBOARD INSTRUMENT)

Music Theory – MU 320, 321, 325 and 428

Music History and Literature – MU 445 and 446

Performance Pedagogy – MU 481

Special requirements for Organ Majors – MU 351 and 449

MAJOR IN PERFORMANCE (VOICE OR ORCHESTRAL INSTRUMENT)

Music Theory – MU 320 and 325

Music History and Literature – MU 445 and 446

Performance Pedagogy – MU 481

Ensemble – 4 additional semester hours of credit

MAJOR IN THEORY AND COMPOSITION

Music Theory – MU 320, 321, 323 (4 semesters), 325, 428, 429, 430, 433, 434 and 482.

Music History and Literature – MU 445, 446, and 3 hours elected by the student

Conducting – MP 339/340

In each area of specialization, electives to reach a total of 84 hours in music will be selected by the student in consultation with his advisor.

Bachelor of Arts in Education Degree Curriculum:

Course Requirements for a Major in Music Education.

Music – Consists of a minimum of 60 hours of credit. This curriculum offers fields of specialization in instrumental music and choral or general music for those wishing to teach music in the public schools. Both fields of specialization require the following basic core:

Music Theory – MU 125, 322, 427, and 3 courses selected from MU 220, 221, 222 and 223

Music History and Literature – MU 241, 242

Conducting – MP 209

Major Performing Medium – 16 semester hours of MP 111/311

Class Piano – MP 131, 132, 231 and 232 (unless waived by proficiency examination)

Additional music requirements for each field of specialization are as follows:

MAJOR IN CHORAL/GENERAL MUSIC

Music Theory – MU 431

Conducting – MP 339

Music Education – ME 313, 480 and 314 for General Music

Voice – 8 semester hours (if voice is not the major performing medium)

Ensemble – 5 semesters of MP 351 or 352 and 3 semesters of electives

MAJOR IN INSTRUMENTAL MUSIC

Music Theory – MU 433

Conducting – MP 340

Music Education – ME 315, 325, 326, 327, 328, 336, 337, 338 and 483

Ensemble – 5 semesters of MP 345 or 361 and 3 semesters of electives

Course Requirements for a Music Minor for Elementary Education Major

Music Theory – MU 100, 101

Music History and Literature – MU 340

Music Education – ME 313

Piano – 4 semesters

Electives – 4 semester hours

Minors for students in Secondary Education and students in Liberal Arts are available through the Department of Music. Consult with the music department office for advisement sheets and advisors.

Departmental Graduate Programs

The Department of Music offers programs leading to the degree of Master of Arts and Master of Music. Consult the *Graduate Catalog* for requirements. The Master of Arts in education and the Doctor of Education in music are also offered by the Department of Music in cooperation with the College of Education.

MUSIC

MU 100 Fundamentals of Music Notation. To provide nonmusic majors with sufficient symbol literacy to begin work in the field of musical learning. No credit for music majors. Three hours a week. Credit, 2 hours.

101 Foundations of Music Theory. A survey of music theory. Prerequisite: MU 100 or approval of instructor. No credit for music majors. This course may be used to meet the music theory requirements for a minor in music. Three hours a week. Credit, 2 hours.

107 Introduction to Music. Correlation of music with literature, science and art. A non-technical course in the humanities for non-music majors. Credit, 2 hours.

125 Introduction to Musical Styles. Designed to develop musical skills and general musician-

ship in the context of a study of musical styles. Two lectures, 3 discussion periods. Credit, 3 hours.

220 Music Theory – 16th Century. Significant compositions and theories from 1400 to 1600. Basic theories of Tinctoris, Ramos, Glarean and Zarlino will be surveyed as they apply to the music under consideration. Development of related aural, visual and keyboard skills. Prerequisite: MU 125. Credit, 3 hours.

221 Music Theory – 18th Century. Music from the 18th century with a view toward developing students' abilities to analyze, theorize, perform and create examples within the style. Development of related aural, visual and keyboard skills. Prerequisite: MU 125. Credit, 3 hours.

222 Music Theory – 19th Century. Musical compositions chosen from the late 18th and the 19th century. Harmonic progressions, melodic construction and rhythmic developments; development of related aural, visual and keyboard skills. Prerequisite: MU 125. Credit, 3 hours.

223 Music Theory – 20th Century. Representative 20th century compositions with particular emphasis on those elements of melodic, harmonic and rhythmic treatment which break with past conventions. Development of related aural, visual and keyboard skills. Prerequisite: MU 125. Credit, 3 hours.

241, 242 Music History and Literature. Western music from the Greeks to the present day. Prerequisite: MU 125. Credit, 3 hours, each semester.

250 Diction for Singers. The use of phonetics in the study of song and opera literature. May be repeated for credit. Credit, 1 hour.

320, 321 Counterpoint. First semester, strict counterpoint in modal style; second semester, strict and free tonal counterpoint. Prerequisites: MU 125 and one semester from MU 220, 221, 222, 223. Credit, 2 hours each semester.

322 Musical Acoustics. A "physics of sound" course primarily for musicians. The nature

of sound, its behavior in general, as applied to musical instruments, the human voice, the ear, and to auditoriums. Musical scales and temperament and the physics of harmony in music history and modern practice, analyzers and synthesizers. Credit, 4 hours. (Not open to students who have elected PH 320.)

323 Composition. Creative writing in the smaller forms including the use of harmonic textures and contrapuntal devices. May be repeated for credit. Credit, 2 hours.

325 20th Century Theory. Meets daily. Credit, 3 hours.

340 Survey of Music History and Literature. Major periods, composers and compositions in the history of music. A humanities course in the General Studies program. This course may be used to meet the music history requirement for a minor in music. Credit, 3 hours.

351 Service Playing and Improvisation. Basic principles of hymn playing and accompanying; fundamentals of improvisation for the church organist. Credit, 2 hours.

355 Survey of American Music. Growth and development of America's music. A humanities course in the General Studies program. Credit, 2 hours.

356 Survey of the Musical Theatre. An examination of music's place in the theatre, viewed in terms of its historical importance and relative function. A humanities course in the General Studies program. Credit, 2 hours.

427, 428 Form and Analysis. Harmonic and structural analysis of musical forms. Prerequisites: MU 125 and 3 semesters from MU 220, 221, 222, 223. Credit, 2 hours each semester.

429, 430 Canon and Fugue. Polyphonic studies in form and technique. Prerequisite: MU 321. Credit, 2 hours each semester.

431 Choral Arranging. Practical studies in editing and arranging for choral organizations. Preparation of suitable materials for young choirs as well as for advanced groups. Study

of accompaniments. Prerequisites: MU 125 and 3 semesters from MU 220, 221, 222, 223. Credit, 2 hours.

433, 434 Orchestration. Theoretical and practical study of scoring for orchestral instruments in various combinations, ranging from small ensembles to symphonic orchestra and concert band. Prerequisites: MU 125 and 3 semesters from MU 220, 221, 222, 223. Credit, 2 hours each semester.

438 Music in the Classic Era. Development of the classic style as exemplified by the works of Haydn, Mozart and Beethoven. Prerequisites: MU 241, 242. Credit, 3 hours.

439 Music in the 19th Century. A survey of European art music after Beethoven. Prerequisites: MU 241, 242. Credit, 3 hours.

441 Music of the Baroque Era. Works of major composers; the salient stylistic tendencies of the period. Prerequisites: MU 241, 242. Credit, 3 hours.

445 20th Century European Music. Individual idioms and stylistic currents among major composers. Prerequisites: MU 241, 242, and 427 — may be taken concurrently. Credit, 2 hours.

446 20th Century American Music. American response to European traditions; individuality in composition and jazz. Prerequisites: MU 241, 242, and 427 — may be taken concurrently. Credit, 2 hours.

447 Choral Literature for the Church. Selection and study of music literature appropriate for children's, youth and adult church choirs. Credit, 2 hours.

449 Worship, Liturgy and Hymnody. Various worship concepts and the consequent developments in liturgy and hymnody. Credit, 2 hours.

451 Repertoire. Literature available for performance in all performing media. Prerequisite: junior standing in major performance field. May be repeated for credit. Credit, 2 hours.

453 Performance Practices of Early Music.

Manners of performance of earlier times, including rhythmic expression, ornamentation and technique. Credit, 3 hours.

458 Church Music Administration. Form and content of the unified and integrated church music program. Credit, 2 hours.

459 History of Organ Design. Historical survey and practical application of the principles of organ construction and total design. Credit, 2 hours.

481 Performance Pedagogy and Materials. Principles and methods of performance techniques for each performance field. Prerequisite: senior standing or approval of instructor. May be repeated for credit. Credit, 2 hours.

482 Theory of Rhythm. An integration of musical organization through physiological and psychological principles based upon rhythmic perception. Prerequisites: MU 428, 445; MP 339 or 340. Credit, 2 hours.

484 Voice Clinic and Master Class in Voice Pedagogy. Examination of the singer's vocal production mechanism and study of techniques for retraining voices. May be repeated for credit. Credit, 2 hours.

501 Theory Techniques. Theory techniques required of graduate students. Two hours a week. Credit, 2 hours. (Credit in this course will not apply towards meeting graduate degree requirements.)

502 History of Musical Style. Periods of music history treated from a stylistic viewpoint. Two hours a week. Credit, 2 hours. (Credit in this course will not apply towards meeting graduate degree requirements.)

510 Introduction to Graduate Study. Designed to acquaint the graduate student with basic research materials in music. Bibliographic and technical materials will be incorporated into the preparation and writing of research papers. Credit, 2 hours.

520 Advanced Analytical Techniques. Analytical techniques systematically applied to music. Concentration on structural and compositional procedures. Credit, 2 hours.

523 Advanced Composition. Creative writing in the larger forms for chorus, orchestra and band. Prerequisites: MU 323, 428, 445 or equivalent. May be repeated for credit. Credit, 2 hours.

525, 526 Pedagogy of Theory. Practices and principles of teaching music theory. Emphasis directed toward setting up the most desirable and practical offerings possible. Comparative studies of existing practices. Credit, 3 hours each semester.

527, 528 Evolution of Musical Theory. Theory from Pythagoras to the present. Credit, 3 hours each semester.

530 Music Notation. Early monophonic and polyphonic notation. May be repeated for credit. Credit, 3 hours.

532 Music Bibliography. Reading knowledge of a foreign language recommended. Credit, 3 hours.

536 Music of the Renaissance. Musical thought in Europe, with emphasis on stylistic concepts and changes, c. 1430-1580. Credit, 3 hours.

541 The Art Song. Solo song from its beginning to the present day. Credit, 3 hours.

542 Keyboard Literature. From the Renaissance to the present day. Credit, 3 hours.

544 Music of Non-Western Cultures. Non-Western music cultures of the world, the role of music in nonliterate societies, and its relationship to other aspects of culture. Credit, 3 hours.

553 Advanced Choral Arranging. Choral techniques in composition and arranging. Vocal writing through analysis of choral works. Projects in both arranging and composition. Credit, 2 hours.

554 Advanced Scoring Problems. Instrumentation. Further study of the playing characteristics of each instrument in order to write and arrange idiomatic music for the instrument. Projects in both scoring and composition. Credit, 2 hours.

575 History of Choral Music. Major choral works written since 1600. Credit, 3 hours.

591 Seminar. Credit, 3 hours. Topics may be selected from the fields of music history and music theory:

- (a) Ancient and Medieval Music
- (b) Ethnomusicology
- (c) American Music to 1900
- (d) Jazz
- (e) Symphonic Literature
- (f) Chamber Music Literature
- (g) Biographical Studies
- (h) Computer Generated Sound

Special Graduate Courses: 580, 590, 592, 593, 594, 680, 790, 791, 792. (See pages 46-47).

MUSIC EDUCATION

ME 311 Music for the Classroom Teacher. Development of the classroom music program in the elementary school. No previous music experience or course work required. Not for music majors or minors. Three hours each week. Credit, 3 hours.

313 Music in the Elementary School. Methods of instruction, organization and presentation of appropriate content in music. For music majors and minors only. Credit, 3 hours.

314 Music in the Elementary School. Selected problems in elementary school classroom music. The elementary school choral program. Observation and participation in school music classrooms. Prerequisite: ME 313. Credit, 3 hours.

315 Instrumental Music in the Elementary and Junior High School. Instrumental music as a means of developing musical understanding. Emphasis on selection of instructional objectives, planning of sequential learning experiences, criteria for the selection of materials and administrative procedures. Credit, 3 hours.

325, 326 Educational Methods for Strings. Practical class in gaining the string knowledge

necessary for instrumental teachers in public schools. Three hours a week. Credit, 1 hour each semester.

327, 328 Educational Methods for Brass. Practical class in gaining the brass knowledge necessary for instrumental teachers in public schools. Three hours a week. Credit, 1 hour each semester.

336 Educational Methods for Percussion. Practical class in gaining percussion knowledge necessary for instrumental teachers in public schools. Three hours a week. Credit, 1 hour.

337, 338 Educational Methods for Woodwinds. Practical class in gaining the woodwind knowledge necessary for instrumental teachers in public schools. Three hours a week. Credit, 1 hour each semester.

462 Elementary School Music Materials. Books, music, primary instruments, phonograph records and films for primary, intermediate and upper grades. Credit, 1 hour.

464 Listening Activities in the Elementary School. Phonograph recordings, films and radio programs suitable for use with experience units in the elementary grades. For classroom teachers and music teachers. Credit, 2 hours.

480 Choral Music Practicum. Methods of instruction, organization and presentation of appropriate content in choral music. Credit, 3 hours.

483 Instrumental Music Practicum. Methods of instruction, organization and presentation of appropriate content in instrumental music. Credit, 3 hours.

550 Studies in Music Curricula. Scope and sequence of musical experiences. Development of criteria for the evaluation of music curricula in terms of growth and interest. Credit, 3 hours.

551 Advanced Studies in Elementary School Music. For experienced teachers; organization and content of the general vocal music class in kindergarten and the first six grades of elementary school. Emphasis on teaching

music reading and ear training to young children. Credit, 3 hours.

552 General Music, Music Theory and Music History Classes in the Junior and Senior High School. Organization and content of school music classes which are not performance oriented. Credit, 3 hours.

564 Instrumental Music, Advanced Rehearsal Techniques. Rehearsal management and techniques, programming, staging, scoring, problems of instrumental care and maintenance, the marching band. Credit, 3 hours.

566 Instrumental Literature for Schools. Comprehensive study and analysis of all types of instrumental music. Credit, 3 hours.

568 Choral Music, Advanced Rehearsal Techniques. Musical and vocal techniques necessary for presentation of choral literature. Analysis and experimentation with psychological, acoustical and other problems of rehearsal and performance. Credit, 3 hours.

570 Choral Literature for Schools. Comprehensive study and analysis of all types of choral music. Credit, 3 hours.

591 Seminar. Credit, 3 hours. Topics selected as required or needed in graduate programs, including Music and Society.

733 Experimental Projects and Recent Trends in Music Education. Recent trends and research developments which challenge traditional practices. Credit, 3 hours.

744 Major Problems in the Education of Music Teachers. A review of existing patterns of music teacher education and a projection of course outlines designed to accommodate the more comprehensive demands of the changing school music curriculum. Credit, 3 hours.

755 Philosophies of Music Education. History of music education and the psychologies and philosophies influencing changes in curriculum content and teaching procedures. Credit, 3 hours.

Special Graduate Courses: 580, 590, 591, 592, 593, 594, 680, 790, 791, 792 (See page 46).

MUSIC PERFORMANCE

MP 111, 311, 511 Applied Music — Private Instruction. Music majors only. Piano, organ, harp, harpsichord, voice, violin, viola, violoncello, contrabass, flute, oboe, clarinet, bassoon, saxophone, trumpet, cornet, French horn, baritone, trombone, tuba, percussion. Placement examination required. Two half-hour lessons a week. May be repeated for credit. Credit, 2 hours each semester.

121, 321, 521 Applied Music — Private Instruction. Piano, organ, harp, harpsichord, voice, violin, viola, violoncello, contrabass, flute, oboe, clarinet, bassoon, saxophone, trumpet, cornet, French horn, baritone, trombone, tuba, percussion. Placement examination required. One half-hour lesson a week. May be repeated for credit. Credit, 1 hour.

127, 327, 527 Applied Music — Private Instruction. Performance majors only. Piano, organ, harp, harpsichord, voice, violin, viola, violoncello, contrabass, flute, oboe, clarinet, bassoon, saxophone, trumpet, cornet, French horn, baritone, trombone, tuba, percussion. Placement examination required. Two half-hour lessons a week. May be repeated for credit. Credit, 2 or 4 hours each semester.

131, 132, 231, 232 Class Piano. A four-semester sequence of courses designed for those lacking piano experience and those who need piano as a classroom tool. Emphasis on keyboard technique, sight reading, simple accompaniments and improvisation. Two hours a week. Credit, 1 hour each semester.

133, 134, 233, 234 Class Voice. Open to all students interested in the development of basic singing techniques. Two hours a week. Credit, 1 hour each semester.

209 Elements of Conducting. Essentials of conducting techniques used by both choral and instrumental conductors. Two hours a week. Credit, 1 hour.

339 Choral Conducting. Elements of choral conducting technique and interpretation.

Prerequisite: MP 209. Three hours a week. Credit, 2 hours.

340 Instrumental Conducting. Fundamentals of score reading and interpretation of instrumental music. Prerequisite: MP 209. Three hours a week. Credit, 2 hours.

345 Symphony Orchestra. Open to all students who can qualify on the basis of auditions with the director. Over a four-year period, the student is introduced to the masterpieces of symphony orchestra literature. Five hours a week. May be repeated for credit. Credit, 1 hour.

351 Choral Union. Open to all students in the University and to interested singers in the community. Time devoted to preparation and performance of the larger choral works. May be repeated for credit. Credit, 1 hour.

352 Concert Choir. Membership chosen by audition. May be repeated for credit. Four hours a week. Credit, 1 hour.

355 Men's Glee Club. Open to all male students in the University who can qualify on the basis of auditions with the director. Rehearsal and performance of music for male voices. Three hours a week. May be repeated for credit. Credit, 1 hour.

357 Women's Chorus. Membership chosen by audition. Three hours a week. May be repeated for credit. Credit, 1 hour.

361 Symphonic and Marching Band. Open to all students who can qualify on the basis of auditions with the director. Staging of formations and drills for football games and other events; masterpieces of symphonic band literature. Meets daily. May be repeated for credit. Credit, 1 hour.

371 Musical Theatre. Open to all students who can qualify on the basis of auditions with the instructor.

Section 1 (Interpretation): Exercises, improvisations and musical/dramatic interpretation for the singing actor. One lecture-demonstration, 1 laboratory per week.

Grady Gammage Memorial Auditorium





Section 2 (Orchestra): Participation in Lyric Opera Theatre productions. Two-and-a-half hours per week.

Section 3 (Production): Participation in Lyric Opera Theatre productions. Three hours per week.

Section 4 (Musical comedy): Musical/dramatic interpretation of musical comedy materials. One lecture-demonstration, 1 laboratory per week.

Section 5 (Opera scenes): Rehearsal and production of opera scenes. One lecture-demonstration, 1 laboratory per week.

All sections may be repeated for credit. Credit, 1 hour.

381 Chamber Music Ensembles. String, brass, woodwind, percussion, keyboard, accompanying, vocal and mixed ensembles, stage band, and contemporary music ensemble. Prerequisite: approval of instructor. Two hours a week. May be repeated for credit. Credit, 1 hour.

382 Collegium Musicum. Singers and instrumentalists specializing in the performance of early and unusual music. Prerequisite: approval of instructor. Two hours a week. May be repeated for credit. Credit, 1 hour.

383 University Singers. Small choral ensemble chosen by audition. Two hours a week. May be repeated for credit. Credit, 1 hour.

384 Brass Choir. Specializing in public performance of music written for brass instruments. Prerequisite: approval of instructor. Two hours a week. May be repeated for credit. Credit, 1 hour.

385 Percussion Ensemble. Rehearsal and performance of standard and original repertoire for the percussion ensemble and related instruments. Membership by approval of the instructor. Two hours a week. Credit, 1 hour.

539 Advanced Conducting. Advanced baton technique for band and orchestra. Score reading, mechanics of conducting, individual criticism of style. Prerequisites: MP 339, 340 or equivalent. Credit, 2 hours.

595, 596 Solo Performance. For Master of Music candidates in applied music only. May be full recital, major operatic role, solo performance with orchestra, or an ensemble or lecture recital. Credit, 1 hour each semester.

Speech and Theatre

Professors:

RICHARDS (LL 605), DAVIS, STITES, YEATER

Associate Professors:

CLUFF, DOYLE, MOWRER, PERRILL, WITT

Assistant Professors:

BARTZ, CASE, DOBKIN, ELSEA, GOHEEN, HETHERINGTON, RICE, RITTERBUSH, SMITH, SNELLING, SORVIG, WILLSON

Departmental Major Requirements

Bachelor of Arts Degree Curriculum:

SPEECH — Consists of 45 semester hours, of which at least 24 hours must be in speech communication courses and 15 in one or more related areas. At least 18 hours must be in upper division courses. The major should include courses in public speaking, oral interpretation, argumentation or persuasion, group communication, and history and criticism of public address; specific courses are selected by the student in conference with his advisor to provide emphasis in theory, practice and criticism of oral discourse. This program is designed to provide preparation for such fields as law, politics, college teaching and the ministry.

THEATRE — Consists of 45 semester hours of credit selected in consultation with an advisor to provide a balanced representation of courses within areas of theatre specialization. The selected program must include at least one course in acting, one in directing, two in

theatre history and criticism, and three in different aspects of technical theatre and design. In addition, at least 2 hours, but no more than 4 hours are required in TH 301, chosen from at least two different production options. The theatre major will normally include 15 semester hours of course work in such related studies as speech, English, dance, music, art and mass communications.

Bachelor of Science Degree Curriculum:

COMMUNICATION DISORDERS — Consists of 45-50 semester hours of credit and provides areas of emphasis in speech pathology and in audiology. The speech pathology emphasis requires 27 semester hours in speech pathology and 3 in audiology, with the remainder in related fields such as psychology and special education. The audiology emphasis consists of a core of 14 semester hours in audiology and 10 in speech pathology, with the remainder selected from courses in physics, mathematics, psychology and electronics. Students pursuing either emphasis should plan the program of studies carefully with an academic advisor in speech pathology or audiology. Since this is a professional program which assumes the completion of a master's degree for certification, a student will normally be expected to have achieved a 2.5 grade point average by the time he reaches junior standing.

SPEECH COMMUNICATION—Consists of 45-55 semester hours, of which at least 24 must be in speech communication courses and a minimum of 15 in one or more related areas approved by the advisor in consultation with the student. At least 18 semester hours must be in upper division courses. The major must include courses in public speaking, oral interpretation, group communication, argumentation or persuasion, and communication theory or public address; specific courses

are selected by the student in conference with his advisor to provide specialization in speech communication behavior. This program intends to provide preparation for such fields as business and organization communication, public service, law, or college teaching.

Departmental Major Teaching Field Requirements

Bachelor of Arts in Education Degree Curriculum:

SPEECH COMMUNICATION — Consists of 36 semester hours and anticipates the addition of a minor (24 hours). Speech communication majors should complete at least one course in each of the following areas: public speaking, oral interpretation, argumentation or debate, discussion or persuasion or history and criticism of public address. The student will normally elect at least one course in communication disorders. At least 2 semester hours must be earned in speech activities (SC 301) but not more than 4 hours may be counted toward the major. Specific courses to complete the major are selected by the student in conference with his academic advisor.

THEATRE — Consists of 42 semester hours of credit which will include TH 100, 110, 113, 213, 214, 315, 316, 320, 321, 330, 340, 345, 415. In addition, the major is required to accumulate at least 3 hours credit in TH 301 and give evidence of having participated in the production areas of lighting, costume, make-up, properties and scenery construction for University Theatre productions, under faculty supervision. Each major will also stage one production with high school students. A teaching minor is strongly recommended to accompany this major.

COMMUNICATION ARTS — Consists of 60

semester hours and is designed to provide basic preparation for teaching in three fields. A communication arts major must complete a minimum of 24 semester hours in speech communication or theatre and at least 18 hours in each of two other related subject fields. (For example, 24 hours in speech communication, 18 hours in theatre, and 18 hours in mass communication: or, 24 hours in theatre, 18 hours in speech communication, and 18 hours in English.) Other combinations are possible in this major pattern. Students will be expected to elect a minimum of 2 hours in appropriate activities courses (SC 301 and/or TH 301), but not more than 4 hours will be counted toward the major. Specific courses normally will be drawn from the minor requirements in each subject field and are selected by the student in conference with the academic advisor.

MINOR IN SPEECH COMMUNICATION — Consists of 24 semester hours and will normally include the following: SC 120, 480, and one course in public speaking, oral interpretation, argumentation or debate, and discussion, persuasion, or history and criticism of public address, plus 6 hours of electives. At least 9 hours must be in upper discussion courses.

MINOR IN THEATRE — Consists of 24 semester hours in theatre courses. TH 100, 110, 213, 214, 315 are required; plus one additional course in theatre history and two additional courses in technical theatre.

Departmental Graduate Programs

The Department of Speech and Theatre offers programs leading to the degrees of Master of Arts and Master of Science. Consult the *Graduate Catalog* for requirements.

THEATRE

TH 100 Introduction to Theatre. A survey of all elements of the theatre: playwriting,

directing, acting, design and architecture. Credit, 3 hours.

110 Survey of Acting. An introduction to acting methods and theories with laboratory projects in acting, mime, make-up and movement. Two hours lecture-demonstration, 2 hours laboratory. Credit, 3 hours.

113 Make-Up. Techniques of theatrical make-up; laboratory projects. Prerequisite: TH 110 or approval of instructor. Credit, 2 hours.

212 Acting Expression. Bodily and vocal expression for acting through exercises and performances. Prerequisite: TH 110 or approval of instructor. Credit, 3 hours.

213 Introduction to Technical Theatre. Design and construction of scenery, lighting, costumes and properties. Credit, 2 hours.

214 Technical Theatre Practicum. Demonstrations and laboratory projects in procedures of technical theatre production. Three hours laboratory. Prerequisite: TH 213 or approval of instructor. May be taken concurrently with TH 213. Credit, 2 hours.

215 Technical Drawing for the Theatre. Exercises in techniques of perspective, renderings, and working drawings necessary for scene and costume design. Prerequisite: TH 213. Credit, 2 hours.

301 Theatre Production. Participation in University Theatre productions. Prerequisite: written approval of instructor. May be repeated for credit. Credit, 1 hour.

311 Creative Dramatics. Theories, procedures and materials for creative dramatics in the elementary and junior high schools. Consideration of related speech activities such as story telling, choral speaking and puppetry. Credit, 3 hours.

312 Acting: Improvisation. Emotional and expressive freedom for acting through improvisational theatre techniques. Prerequisites: TH 110 and 212, or approval of instructor. Credit, 2 hours.

313 Make-Up: Special Problems. Special prob-

lems, styles and materials for stage make-up. Prerequisite: TH 113 or approval of instructor. Credit, 2 hours.

314 Acting: Characterization. Techniques and methods of interpreting and projecting a role through study and performance. Prerequisites: TH 110 and 212 or approval of instructor. Credit, 3 hours.

315 Directing. Techniques of interpreting and directing plays. Prerequisites: TH 100, 110 and 213. Credit, 2 hours.

316 Directing Projects. Practice in directing scenes with student actors. Prerequisite: TH 315 or approval of instructor. Two hours laboratory. Credit, 1 hour.

318 Children's Theatre. Acting, directing and producing techniques for child audiences. Includes participation in a children's theatre production. Credit, 3 hours.

320, 321 History of the Theatre. First semester traces major developments in theatre production from its beginning through the 17th century; second semester continues the survey to modern times. Credit, 3 hours each semester.

330 Introduction to Costuming. History of theatrical costume; laboratory projects in construction of costumes. Two hours lecture, 3 hours laboratory. Prerequisite: TH 213 or approval of instructor. Credit, 3 hours.

335 Technical Theatre: Stagecraft. Practices in material selection, drafting of working drawings, tool operation and construction techniques in modern stagecraft. Two hours lecture, 3 hours laboratory. Prerequisite: TH 213 or approval of instructor. Credit, 3 hours.

340 Scene Design. Theory and practice of scene design for the theatre. Laboratory projects. Prerequisite: TH 213. Credit, 3 hours.

345 Technical Theatre: Lighting. Electrical and design principles of modern stage lighting, design and operation of sound effects. Two hours lecture, 3 hours laboratory. Prerequisite: TH 213 or approval of instructor. Credit, 3 hours.

410 Technical Theatre: Contemporary Concepts. Modern theories of theatre production, including contemporary concepts of theatre architecture. Laboratory projects. Credit, 3 hours.

411 Advanced Studies in Creative Dramatics. Application of theories, techniques and materials for dramatization. Regular participation with children. Prerequisite: TH 311 or approval of instructor. Credit, 3 hours.

414 Acting: Styles. Techniques of acting in major nonrealistic styles through scene study and performance. Two hours lecture-demonstration, 2 hours laboratory. Prerequisite: TH 312 and/or approval of instructor. Credit, 3 hours.

415 Directing: Theories and Styles. Theories of play direction and laboratory projects in various periods, lyric and experimental plays with student actors. Two hours lecture-demonstration, 2 hours laboratory. Prerequisite: TH 315 or approval of instructor. Credit, 3 hours.

417 Scene Study. Analysis and presentation of scenes from masterpieces of theatre literature. Prerequisite: TH 414 or 415 or approval of instructor. Credit, 2 hours.

420 History of the American Theatre. History of the plays, artists and events in the development of the American theatre from colonial to modern times. Credit, 3 hours.

425 History of the Oriental Theatre. History and production techniques of theatre forms in India, Southeast Asia, China and Japan with exercises in the various acting styles of these countries. Prerequisite: 6 hours of theatre history or approval of instructor. Credit, 3 hours.

430 Advanced Costume Design. Special design and construction practices, particularly in period costume. Prerequisite: TH 330. Credit, 3 hours.

440 Advanced Scene Design. Specialized techniques in modern scene design. Prerequisite: TH 340. Credit, 3 hours.

445 Technical Theatre: Advanced Lighting.

Specialized techniques in stage lighting, including design practices for arena and thrust stages. Prerequisite: TH 345 or approval of instructor. Credit, 3 hours.

450 Theatre Organization and Management. Principles of administering professional and nonprofessional theatre production organization. Credit, 2 hours.

460 Playwriting. Fundamentals and theories of playwriting. Class work culminating in the writing of a short play. Credit, 3 hours.

465 Dramatic Theory and Criticism. Major dramatic theories and criteria from the classical period through the 20th century. Credit, 3 hours.

510 Studies in Theatre Literature. Assigned readings in standard sources and masterpieces in theatre literature. Credit, 3 hours.

570 Creative Research Project. Project in lieu of thesis in one area of theatre production. Credit, 3 hours.

591 Seminar. Credit, 3 hours. Topics may be selected from the following:

- (a) Theatre History: Renaissance
- (b) Theatre History: 17th century
- (c) Theatre History: 19th century
- (d) Theatre History: Contemporary Period
- (e) Dramatic Theory and Criticism
- (f) Acting
- (g) Directing
- (h) History of Scene Design
- (i) Technical Theatre Planning and Production
- (j) Children's Theatre and Creative Dramatics
- (k) History of the Oriental Theatre

SPEECH COMMUNICATION

SC 100 Elements of Speech Communication. Basic theory and principles of the speech communication process. Individual and group experiences such as public speaking, discussion and oral reading. Credit 3 hours.

120 Survey of Speech Communication. Orientation to the field of speech communication as an academic discipline. Theory and limited practice in group communication, public speaking, speech science, oral interpretation, history and criticism of public address. Credit, 3 hours.

200 Introduction to Human Communication. Human communication processes and systems. Orientation to the communication experience and the scientific bases of speech behavior. Credit, 3 hours.

211 Public Speaking. The preparation and delivery of various forms of public speeches: informational, persuasive, political, eulogistic. Current speakers on the American scene as examples of excellence. Prerequisite: SC 100 or 120 or approval of instructor. Credit, 3 hours.

214 Introduction to Forensics. Examination of practical problems involved in the development and presentation of argument, including participation in intercollegiate debate. Credit, 3 hours.

221 Voice Improvement. Intensive personal and group experiences to improve normal vocal usage, including articulation and pronunciation for platform, stage or mass media. Credit, 3 hours.

241 Oral Interpretation. Techniques of reading aloud prose, poetry and drama. Prerequisite: SC 100 or 120. Credit, 3 hours.

300 Principles and Methods of Group Communication. Development of attitudes and skills for effective participation and leadership in group communication. Practice in small group panels, symposiums and conferences. Prerequisite: approval of instructor. Credit, 3 hours.

301 Speech Communication Activities. Participation in speech communication activities. Prerequisite: written approval of instructor. May be repeated for credit. Credit, 1 hour.

310 Parliamentary Procedure. Theory of par-

liamentary law. Practice in organizing and conducting parliamentary proceedings. Credit, 2 hours.

312 Principles of Argumentation. Philosophical and theoretical foundations of argumentation with emphasis on problems in argumentation and debate. Prerequisite: SC 214 or approval of instructor. Credit, 3 hours.

341 Oral Interpretation of Dramatic Literature. Study of dramatic literature for purposes of developing understanding, appreciation and ability to communicate orally. Prerequisite: SC 241 or approval of instructor. Credit, 3 hours.

400 Leadership in Group Communication. Group communication process and procedure, with emphasis on the philosophy and behavioral nature of leadership in group situations. Prerequisite: SC 300 or approval of instructor. Credit, 3 hours.

410 Forms of Public Address. Advanced theory of the composition and evaluation of various types of public address: campaign speeches, courtroom addresses, after-dinner speaking, eulogies, legislative speaking. Limited practice in the preparation and delivery of speeches. Credit, 3 hours.

411 Speech Communication in Business and Profession. Application of principles of oral communication to specific business and professional communication situations. Practice in using the forms of persuasion, conference speaking techniques and group participation methods. Credit, 3 hours.

415 Speech Improvement for the Classroom Teacher. Intensive training in the organization, amplification and oral presentation of materials; to provide improvement in the oral skills of classroom teachers. Credit, 3 hours.

441 Oral Interpretation of Prose. Study of prose literature for purposes of understanding appreciation and oral communication. Prerequisite: SC 241 or approval of instructor. Credit, 3 hours.

442 Oral Interpretation of Poetry. Study of poetry for purposes of understanding, appre-

ciation and oral communication. Prerequisite: SC 241 or approval of instructor. Credit, 3 hours.

450 Contemporary Public Address. Leading contemporary public speakers and their influence on social and political life. Credit, 3 hours.

460 American Public Address. Survey and rhetorical evaluation of outstanding American speakers from the 17th to 20th century. Credit, 3 hours.

470 British Public Address. Survey and rhetorical evaluation of outstanding British orators. Credit, 3 hours.

473 Persuasion. Study and practice of persuasive principles that influence and modify the belief and action of an audience. Prerequisite: SC 100 or 312. Credit, 3 hours.

480 Methods of Teaching Speech Communication and Theatre. Analysis, organization and presentation of textual and other classroom materials. Credit, 3 hours.

481 Teaching Practicum. Teaching high school students the fundamentals of forensics. Offered in Summer Session only. Credit, 2 hours.

514 Administration of the Forensics Program. Theoretical and practical problems of forensics programs on the college and secondary level. Credit, 3 hours.

570 Research Project in Speech Communication. Project in lieu of thesis in one area of communication arts. Credit, 3 hours.

591 Seminar. Credit, 3 hours. Topics may be selected from the following:

- (a) Classical Rhetorical Theory
- (b) Modern Rhetorical Theory
- (c) Rhetorical Criticism
- (d) Persuasion
- (e) Theories and Criticism of Oral Interpretation
- (f) Group Communication
- (g) Speech Education

- (h) Quantitative Studies in Oral Communication
- (i) Communication Theory
- (j) Organization Communication

COMMUNICATION DISORDERS

SA 167 Speech and Language Behavior in Early Childhood. Processes of speech and language development in the normal child. Credit, 2 hours.

215 Elementary Acoustics in Audiology. Physical characteristics and basic principles of sound propagation, transmission reflection and absorption. Prerequisites: MA 118, 142, PH 111. Credit, 2 hours.

310 Anatomy and Physiology of the Speech and Hearing System. Anatomy and physiology of the neural, muscular and skeletal systems which subserve human speech behavior. Credit, 4 hours.

320 Introduction to Audiology. Normal process of hearing and the nature and causes of auditory pathology. Prerequisite: SA 310. Credit, 3 hours.

350 Phonetics. Speech sounds and the application of the International Phonetic Alphabet to American speech. Credit, 3 hours.

380 Introduction to Communication Disorders. Orientation to disorders of communication. Prerequisite: SA 310. Credit, 3 hours.

390 Problems of Articulation. Detailed analysis of disorders of articulation. Prerequisite: SA 380, or approval of instructor. Credit, 2 hours.

395 Methods in Modification of Communication Disorders. Principles and techniques of modifying speech and language behavior. Two lectures, 4 hours laboratory. Prerequisite: approval of instructor. Credit, 4 hours.

400 Methods of Audiometry. Techniques and instrumentation used in measuring auditory threshold and audiogram interpretation. Prerequisite: SA 215 and 320. Credit, 3 hours.

401 Observation-Participation: Communication

Disorders. Four hours of weekly observation and minimal participation in audiometric testing or treatment of speech disorders. May be repeated once for credit. Prerequisite: SA 395 or SA 400. Credit, 1 hour.

402 Hearing Conservation in the Public Schools. Participation in public school audiometric testing programs, with classroom discussion. Prerequisite: SA 401. Credit, 2 hours.

420 Orientation to Speech and Hearing Problems in the Classroom. Roles of the teacher and parent in understanding and aiding speech and hearing development in normal and speech-defective children, with emphasis on the recognition and prevention of disorders. May not be counted toward the major in Communication Disorders. Credit, 3 hours.

427 Practicum in Audiometric Testing. Practical application of techniques in audiometry. Two hours discussion, 6 hours laboratory. Prerequisites: SA 401 and approval of the instructor. Credit, 3 hours.

432 Auditory Rehabilitation. Theory and application of speech reading and auditory training. Prerequisite: SA 320. Credit, 3 hours.

434 Pediatric Audiology. Measurement of hearing and principles of rehabilitation of the hearing disadvantaged child. Prerequisite: SA 401. Credit, 3 hours.

435 Industrial Audiology. Hearing problems produced by an adverse listening environment. Prerequisite: SA 400. Credit, 3 hours.

451 Practicum in Speech Disorders. Treatment of speech disorders in the University Center. Prerequisites: SA 401 and approval of the instructor. Credit, 2-3 hours.

464 Internship Practicum in the Public Schools. Treatment of speech disorders within the public school setting. Prerequisite: SA 451. Credit, 3 hours.

467 Evaluation of Speech Disorders. Methods of evaluating speech and language disorders. One lecture, 3 hours laboratory. Prerequisites: SA 310, 350 and 380, or approval of the

instructor. May be repeated for credit. Credit, 2 hours.

491 Stuttering. Causes, therapies and current research trends. Credit, 3 hours.

502 Advanced Audiology. Procedures in differential diagnosis of auditory pathologies. Prerequisite: SA 427. Credit, 2 hours.

519 Experimental Procedures in Audiometry. Use of electronic instrumental and psychophysical measures in auditory research. Prerequisite: SA 400 and 6 hours credit in electronics. Credit, 3 hours.

527 Advanced Practicum in Audiometric Testing. Supervised clinical aspects in hearing testing and evaluation of auditory pathology. One hour discussion, 5 hours laboratory. May be taken concurrently with SA 502. Prerequisites: SA 427, 502 and approval of the instructor. May be repeated for credit. Credit, 3 hours.

576 Neurological Disorders of Speech. Aphasia and cerebral palsy as they affect speech and language behavior. Prerequisite: SA 380, or approval of instructor. Credit, 3 hours.

577 Oral-Laryngeal Disorders of Speech. Speech disorders related to cleft palate and laryngeal pathologies. Prerequisite: SA 310, or approval of instructor. Credit, 3 hours.

586 Programming in Speech Therapy. Basic principles in writing instructional programs designed to modify vocal behavior of children and adults. Credit, 3 hours.

591 Seminar. Credit, 3 hours. Selected topics from fields of speech pathology or audiology.

- (a) Oral-Laryngeal Speech Disorders
- (b) Stuttering Behavior and Therapy
- (c) Administration of Public School Speech Therapy Programs
- (d) Neurological Disorders of Speech
- (e) General Language Disorders
- (f) Instrumentation in Speech Science

Special Graduate Courses: 590, 592, 593. (See pages 46-47.)

College of Law

WILLARD H. PEDRICK, J.D.

Dean

Purpose

The prime function of the College of Law is to train young men and women for the practicing legal profession and related professional assignments. In addition, the College has the responsibility to contribute to the quality of justice administered in our society.

The College of Law offers a three-year program of professional studies at the graduate level leading to the degree of Juris Doctor and entry into the many branches of the legal profession.

Accreditation. The College is fully accredited by the American Bar Association and by the Association of American Law Schools.

Juris Doctor Degree. On completion of the three-year graduate professional course, the Juris Doctor, as the first professional degree in law, is conferred. While the primary mission of the law school is thorough-going professional preparation for the practice of law, many career opportunities are open to law graduates. Government, business, finance, industry and education all call upon men and women with legal training.

The program of study in the College of Law is designed to provide intensive study of the basic legal processes in the first two years of the course, with opportunity in the third year for a variety of educational experiences in seminars, small group courses, clinical activities and, for some, participation in graduate programs in other colleges and departments of the University to add perspective and depth to the individual's program of legal education. Substantial research and writing assignments are features of the program.

Admissions. First-year students are admitted

only for the fall semester in the College of Law.

The formal requirements for admission to the professional course of study leading to the degree of Juris Doctor are:

- (1) An undergraduate degree from an accredited four-year college or university (B.S., B.A., or equivalent);
- (2) A score on the Law School Admission Test (administered by the Educational Testing Service, Box 944, Princeton, N.J., in centers throughout the country).

The deadline for completed applications, with college transcripts on all completed course work and with the LSAT score in the hands of the College of Law, is May 1.

The undergraduate academic record and the score on the Law School Admission Test will be evaluated with the object of selecting those who have a reasonable prospect of success in the rigorous and demanding professional course. Roughly equivalent weight will be given to the college grade average and to the LSAT score.

Law Building. The John S. Armstrong Law Building is part of the central campus, near other graduate schools of the University and the Hayden Library. The Law Building provides every modern facility for legal education and has been described by experts on planning law buildings as setting a new standard in functional design. From 350 to 400 law students can be accommodated comfortably in the completely air-conditioned building.

Law Library. With an "open stack" policy of accessibility to all law students and a rated seating capacity of three-fourths of the total student body, the Law Library contains a substantial collection of law and law-related

books. The modern facility has shelf capacity for approximately 200,000 volumes. The goal is to make the Arizona State University Law Library one of the most outstanding in the country.

Course of Study. The program is designed for full-time students. In the first two years of the three-year program, the course of study is prescribed and incorporates the time-proven techniques of legal education. These first two years give the student — by the “case method,” by the “problem method,” by “Moot Court” and through other techniques — an intensive exposure to the basic legal processes. The third year offers distinctive educational experiences in the nature of a “clinical year” — featuring practice-oriented professional subjects, small group seminars, publication of a law review, participation in the actual rendition of legal services under licensed practitioners through legal aid, public defender and other programs.

Further detailed information concerning the course of study, advice on pre-law courses, admission practices, expense and financial assistance will be found in the *Bulletin* of the College of Law. Requests for the *Bulletin* and for application forms should be addressed to the Office of the Dean, College of Law, Arizona State University, Tempe, Arizona 85281.

College of Law

Professors:

PEDRICK (AH 102d), BADLER, BERCH,
CANBY, CLEARY, DAHL, EFFLAND,
LaFRANCE, LEE, MATHESON, MORRIS, ROSE

Associate Professors:

DIX, FURNISH, SCHROEDER

Assistant Professors:

COHEN, STRONG, VENABLE

LW 501 Contracts. Contract doctrines and their role in the judicial process. Judicial doctrines and, where applicable, the Uniform Commercial Code are studied in the context of contracts covering employment, personal and family arrangements, building and construction, the sale of goods, loans; assignment of wages and accounts receivable. Also examined are statutes of limitations; payment and settlement; remedies and measure of damages; problems of advocacy and counseling. Credit, 3 hours.

502 Contracts. Continuation of 501. Credit, 3 hours.

503. Torts. Protection through the judicial process of personality, property and relational interests against physical, appropriational and defamatory harms. Doctrines of trespass, nuisance, negligence, conversion, deceit, privacy, slander, libel, seduction, alienation of affections, malicious prosecution, inducement of breach of contract and unfair competition are studied in a variety of factual settings. Credit, 3 hours.

504 Torts. Continuation of 503. Credit, 2 hours.

505 Procedure. Common procedural steps in litigation as an aid to understanding the terminology and concepts of procedure. Common law remedies, equitable relief, the extraordinary remedies and the problems arising from

the abolition of the forms of action and the union of law and equity. Credit, 3 hours.

506 Legislation. Use and functions of statutes and legislative materials. Lawyer's role in the legislative process and training in legislative research, bill drafting and interpretation of statutes. Credit, 2 hours.

507 Property. Law of real and personal property, various legal and equitable estates in land, life estates, remainders, concurrent interests, executory interests, limitations on creation of future interests. Modern concepts of property and an introduction to the modern efforts to define the public interest in relationship to the use of the property. Credit, 2 hours.

508 Property. Continuation of 507. Credit, 3 hours.

510 Constitutional Law. Role of courts in the federal system, distribution of powers between state and federal governments, role of procedure in litigation of constitutional questions, fundamental protection for person, property, political and social rights. Credit, 4 hours.

511 Criminal Law and Procedure. Legislative and judicial formulations designed to deal with anti-social activity, the substantive elements of particular crimes, problems in the administration of criminal law and the penal system generally. Criminal procedures as affected by the requirement of the Federal Constitution are examined. The role and responsibilities of the legal profession in the administration and improvement of our system of criminal justice. Credit, 2 hours.

512 Criminal Law and Procedure. Continuation of 511. Credit, 3 hours.

513 Legal Research and Writing. Techniques of research; use of the law library; preparation of legal memoranda. Credit, 1 hour.

550 Administrative Law. Administrative process, emphasizing nature of powers exercised by administrative agencies of government, problems of procedure and scope of judicial review. Credit, 3 hours.

551 Antitrust Law. Legislation and its implementation to prevent monopoly and business practices in restraint of trade, including restrictive agreements involving price-fixing, trade association activities and resale price maintenance, as well as concentration of industrial and commercial control through mergers. Credit, 3 hours.

552 Commercial Law. Law of negotiable instruments, sale and secured transactions with emphasis on the Uniform Commercial Code. Legal problems arising in the distribution of goods. Credit, 4 hours.

553 Conflict of Laws. Problems arising when the operative facts of a case are connected with more than one state or nation. Choice of law, bases of jurisdiction, effect of foreign judgments, underlying federal and constitutional issues. Credit, 3 hours.

554 Corporations. The corporation as a legal tool for organizing the business enterprise in comparison with sole proprietorship and partnership. Relations of stockholders and management, varieties of stock ownership, problems of corporate finance and government regulations to achieve investor protection. Credit, 4 hours.

555 Evidence. Principles and practice governing the competency of witnesses and presentation of evidence, including the rules of exclusion and roles of lawyer, judge and jury under the adversary system. Credit, 3 hours.

556 Federal Income Taxation. Federal income tax in relation to concepts of income, property arrangements, business activity and current tax problems, with focus upon the process of tax legislation and administration. Credit, 3 hours.

557 Procedure II. Obtaining and exchanging information in advance of trial, isolating the area of controversy, disposing of cases or issues without trial, defining the scope of litigation in terms of parties and subject matter, and the relationship between successive litigations. Credit, 2 hours.

558 Procedure III. Litigation through appeal, including jurisdiction, right to jury, selection of jury, withdrawing case from jury, instructing jury, verdicts, judgments, appellate review. Credit, 2 hours.

559 Trust and Estates. Substantive concepts involved in transmitting wealth, including intestate succession, wills and will substitutes, the modern trust as a family protective device, creation of future interests in a planned estate, social restrictions of a nontax nature and methods of devoting property to charitable purposes. Credit, 4 hours.

560 Legal History. Lawyer's contribution to society, emphasizing the lives of eminent lawyers, judges, legal scholars and law-trained statesmen and lawmakers. Credit, 3 hours.

561 Jurisprudence. Philosophic problems inherent in law; relationship of law to ethics, logic and language; selected schools of legal philosophy. Credit, 3 hours.

562 Family Law. Legal and nonlegal problems which an individual may encounter because of his situation as a member of a family. Credit, 3 hours.

563 State and Local Taxation and Finance. State and local government and fiscal federalism; legal, political, economic and social aspects of property, sales, corporate and personal income and other taxes; bonds and governmental indebtedness; social problems facing state and local governments and possible fiscal solutions; tax exemption and tax immunity; problems of litigation. Credit, 3 hours.

564 Corporate Finance. Application of legal materials, training and judgment to problems of small and large-scale corporate enterprises. Problems include selection of the capital structure, public offerings of corporate securities, reorganization of solvent corporate enterprises and corporate dissolution. Credit, 3 hours.

565 Corporate Taxation. Problems in taxability of the corporation, corporate distributions

and corporate reorganizations. Credit, 3 hours.

566 Indian Law. An inquiry into legal problems special to American Indians and tribes. Credit, 3 hours.

567 Advanced Indian Law. Advanced individual and group study in selected problems of administration of tribal justice, economic development, rights of individual Indians. Prerequisite: LW 566. Credit, 3 hours.

568 Law in a Technological Society. Impact of technology on law and society. Such developments as computer science, nuclear energy and high-speed transportation will be considered. Credit, 3 hours.

569 Law and Medicine. Problems raised by the interaction of law and medicine. Credit, 3 hours.

570 Natural Resources Development. Legal problems relating to the acquisition, distribution, development and conservation of natural resources; federal-state and interstate problems; environmental control; public lands. Credit, 3 hours.

571 Insurance. Current trends in the business of insurance; role of government in the insurance field. Credit, 3 hours.

572 Creditor-Debtor Relations. Remedies available to creditors and the protection and relief accorded to debtors. Credit, 3 hours.

573 Legislative Problems. Research methods and the drafting of legislation; lawyer's role as a legislative advocate. Credit, 3 hours.

574 Constitutional Litigation. Selected constitutional cases from inception through judicial decision. Emphasis on special problems of framing constitutional issues and overcoming obstacles peculiar to constitutional adjudication. Credit, 3 hours.

575 Securities Regulation. Selected problems arising under the major statutes concerned with regulating the securities market. Credit, 3 hours.

576 Professional Sports. Unique legal problems relating to professional sports, including



Armstrong Law Building

their relationship to antitrust laws, the nature of the player contracts and associated tax problems. Credit, 3 hours.

577 Social Legislation and the Social Sciences. A particular social problem with legislative implications such as divorce, abortion or organ transplantation will be studied in some detail, with consideration given to information available from psychology, sociology and related fields, and the use of legal skills in drafting legislative solutions. Credit, 3 hours.

579 Selected Problems in Securities Regulation. Emphasis on the development of private

rights of action under the Securities Exchange Act of 1934. Credit, 3 hours.

580 Selected Problems in Taxation. Credit, 3 hours.

584 Consumer Protection. Problems of the individual purchaser in mass markets. Fraud, breach of warranty, holder in due course, usury and unconscionability doctrines for voiding contracts; new protective legislation. Credit, 3 hours.

585 Legal Problems of the Poor. Examination of the legal problems of the poor in such areas

as welfare, housing and consumer law. Techniques for attacking these problems through constitutional provisions and court processes. Credit, 3 hours.

587 Education and the Law. Current legal problems affecting institutions of higher education; relationships with governmental agencies, faculty and students; scope of authority; public liability; financial control. Credit, 3 hours.

588 Water Law. Acquisition of water rights; water use controls; interstate conflicts. Credit, 3 hours.

590 Law and Ecology. Legal problems relating to aspects of environmental quality, including air and water pollution, pesticides, ionizing radiation and household health hazards; existing and proposed federal, state and local governmental regulation; private litigation; international regulation. Credit, 3 hours.

593 Selected Problems in Tort Law. Credit, 3 hours.

595 Election Law. Right to vote; voter registration; party organizations; arrangement of the ballot; third party candidates; campaign financing and spending; campaign literature; broadcasting; participation by public employees; conduct of election day; recounts; districting; initiative, referendum and recall; presidential nominating conventions; the electoral college; computers and elections. Credit, 3 hours.

601 Organization and Responsibilities of the Profession I. Organized bar, distribution of legal services in modern society, economics of the profession, professional canons of ethics for the bar and judiciary and problems in policing the profession. Credit, 3 hours.

602 Organization and Responsibilities of the Profession II. Advanced work on selected problems. Credit, 3 hours.

603 Professional Skills: Interviewing and Counseling. Skills and techniques involved in interviewing and counseling, including interdisciplinary materials from other fields such as psychology and psychiatry. Credit, 3 hours.

604 Professional Skills: Negotiation and Drafting of Legal Instruments. Skills of negotiation in licensing a variety of situations and drafting of typical legal instruments. Credit, 3 hours.

605 Lawyers and Leadership in Society. Research techniques in the social sciences, skills in the use of mass media and techniques of political action as related to the needs of the modern lawyer. Credit, 3 hours.

606 Professional Responsibility I. The ethical responsibilities of the legal profession. Credit, 1 hour.

607 Professional Responsibility II. Continuation of Professional Responsibility I. Credit, 1 hour.

608 Selected Problems in the Administration of Justice. Court congestion, role of para legal personnel, judicial selection methods, arbitration, group legal services, the adversary process, technicalities and justice, lawyer's role in society. Credit, 3 hours.

611 Estate Planning I. Tax laws relating to transfer of wealth both at death and during lifetime, including federal estate tax, gift tax and income taxation of estates and trusts. Credit, 3 hours.

612 Estate Planning II. Preparation of actual estate plans, and implementing legal documents for a variety of typical private clients. Both tax and nontax elements in preparation of the plans will be considered. Prerequisite: LW 611. Credit, 3 hours.

613 Planning for the Business Client. Planning a business organization for maximum efficiency and for achievement of the personal objectives of business owners presented in a variety of situations. Credit, 3 hours.

614 Planning Private Real Estate Developments. Legal aspects of real estate development, including negotiation, legal devices for financing, promotion of sales, leasing problems and compliance with legal controls, as well as creation of private controls over land use. Credit, 3 hours.

621 Practice Court. Students act as lawyers in conducting a case through all stages of trial, from commencement of the action to final judgment. Credit, 3 hours.

622 Techniques of Advocacy. Designed to familiarize students with the skills of the advocate by observation, instruction and participation. Credit, 3 hours.

623 Current Problems of Litigation. Current developments in the field of procedure, such as rules of evidence, rules of procedure, or systems of jury instruction. Credit, 3 hours.

624 Federal Courts. Federal judicial system; relationship of federal and state law; jurisdiction of federal courts and their relation to state courts. Credit, 3 hours.

631 Freedom of Speech. Freedom of speech and its association in competition with a number of governmental and individual interests, including those of preserving order, morality, fair trial and privacy. Credit, 3 hours.

632 Equality in Modern Society. Discrimination, its social and legal effects and remedies. Focus on constitutional, statutory and private organizational attacks upon discrimination on the basis of race, religion, sex or other classifications. Credit, 3 hours.

633 Freedom of Religion. Problems arising under the establishment and free exercise clauses of the First Amendment, including the separation of church and state. Theoretical and practical bases of current federal, state and local governmental policy toward religious institutions. Credit, 3 hours.

634 Protections from Bureaucracy. Proposed and existing mechanisms for protection of individuals from governmental action or inaction. Case studies of the operation of the ombudsman, police civilian review boards and other such institutions. Credit, 3 hours.

635 The Supreme Court. Intensive examination of selected current decisions of the U. S. Supreme Court. Credit, 3 hours.

641 Legal Aspects of Community Renewal. Basic social structure in a community and possibilities of changing the structure to achieve a renewal of the community; legal devices to make more effective the participation of minorities in urban affairs; organization and distribution of legal services in urban areas. Credit, 3 hours.

642 Federal and Local Participation in Urban Problems. Federal programs designed to aid urban areas in solving the problems of an urban society. Relationship of these programs to local governments, individuals and groups within the community. Credit, 3 hours.

643 State and Local Government. Legal problems involved in the organization and administration of governmental units including the city, county, town, village, school district and special district. Credit, 3 hours.

644 Area Planning. Selected legal problems relating to the economic development of a region; intergovernmental relationships; role of private and public planning and the means through which planning is given operative effect. Credit, 3 hours.

651 Labor Relations. Collective bargaining, including the right of employees to organize and to engage in concerted activities; resolution of questions concerning the representation of employees; duty of employers and unions to bargain; administration and enforcement of collective bargaining agreements. Credit, 3 hours.

652 Labor Arbitration and Mediation. Role of the arbitrator and mediator in the settlement of labor-management disputes. Enforceability of awards, procedure and the operation of arbitration associations. Credit, 3 hours.

653 Selected Problems in Labor Law. Advanced questions in the collective bargaining area. Credit, 3 hours.

654 Modern Social Legislation. Significant legislative programs of social insurance and governmental responses to such problems as unemployment and disability. Credit, 3 hours.

661 Criminal Behavior and Criminal Law. Legal problems raised by the various systems of social control. Objectives of the criminal justice system; theories as to the dynamics of criminal behavior and specific questions raised by the behavior of classes of offenders. Credit, 3 hours.

662 Administration of Criminal Justice. Administration of the adult criminal justice system, including issues arising in the initial police stage of the system, the trial process and the sentencing and correctional stages. Credit, 3 hours.

663 Juvenile Justice System. Special prob-

lems in the juvenile system. Credit, 3 hours.

664 Law and Psychiatry. Mental health system as a companion to the adult criminal system and the juvenile justice system in controlling antisocial behavior. Credit, 3 hours.

665 Selected Problems in Criminology. A research course drawing on local sources such as courts and correctional facilities. Papers will be prepared using material gathered in empirical research combining legal analysis with criminology techniques. Credit, 3 hours.

666 Criminal Appeals Seminar. Actual research and preparation of the brief for a criminal case on appeal in the state courts. Credit, 3 hours.

671 Regulated Industries. Nature and extent of regulation imposed on selected industries and of the techniques adopted by administrative agencies in seeking to achieve the varied objectives of public control. Credit, 3 hours.

672 The Legal Monopolies: Patent, Copyright and Labor. Legally created and sanctioned monopolies will be examined and compared on the basis of their justifications, objectives and limitations. Credit, 3 hours.

673 The Competitive Economy. Legal and economic characteristics of selected problems of the industrial organization in the modern economy. Prerequisite: LW 551. Credit, 3 hours.

674 Advanced Regulated Industries. Intensive and detailed examination of one or more of the regulated industries. Prerequisites: LW 551, 671. Credit, 3 hours.

675 Selected Problems in Antitrust. Analysis of the private enforcement techniques in antitrust. Review and analysis of the various defenses, procedural problems and damage issues. Credit, 3 hours.

681 Public International Law. Role of law in international disputes. Drafting and interpretation of treaties and multilateral conventions will be considered. Credit, 3 hours.

682 Regional Organizations. Role of economic

and political multinational organizations and associations. Credit, 3 hours.

683 Selected Problems in International Law. Advanced consideration of selected problems. Credit, 3 hours.

684 Comparative Law. Techniques of analyzing legal institutions in different cultures. Credit, 3 hours.

685 Selected Problems in Comparative Law. Advanced studies on subjects to be decided. Credit, 3 hours.

686 Latin American Legal Institutions. Legal systems of the western hemisphere nations; the activities of American nationals in these nations. Credit, 3 hours.

687 Selected Problems in Developing Nations. Role of the lawyer in encouraging economic development abroad, emphasizing tasks of protecting investment and securing progress. Credit, 3 hours.

688 International Business Transactions. Special problems facing the investor abroad in dealing with nationals and governments. International conflicts of law considered. Credit, 3 hours.

700 Internship in Law. Supervised, practical experience with such agencies as Legal Aid, Public Defender Office, District Attorney's Office and other state and local governmental departments. Credit, 3 or 6 hours.

701 Field Work. Specialized study outside the law school in a particular area where law has an impact. The work must be approved and supervised by a member of the faculty. Credit, 1 to 6 hours.

702 Individual Study. With the approval of a faculty member, a student may research a legal subject of special interest and prepare a paper suitable for publication. Credit, 1 to 3 hours.

703 Law Journal. Members of the staff of "Law and the Social Order" may register for one credit per semester to a maximum of three credits. Credit, 1 hour.

Graduate School of Social Service Administration

Horace W. Lundberg, PH.D.
Dean

Purpose. The graduate program in social work is a two-year course of study leading to the degree of Master of Social Work (MSW).

The curriculum is designed primarily for full-time study through four semesters; entry is limited to the fall semester. Some part-time coursework is available, but no more than ten hours taken as a part-time student may be applied to the MSW.

The need for professional social workers remains high throughout the United States. The School's program affords the student opportunity to integrate academic theory and field experience for professional practice in the ever-expanding field of social work. The diverse heritage and cultures to be found in Arizona also offer stimulating opportunities for service in the Southwest, as well as throughout the nation.

Admission. The admissions requirements are equivalent to and consistent with the University and the Graduate College. A well-rounded undergraduate background is desirable, including 30 semester hours in social and biological sciences (e.g., sociology, psychology, economics, anthropology, political science, public administration and biology).

Application is made directly to the Graduate School of Social Service Administration. For information regarding the course of study, admissions procedure and application forms, write the Office of the Dean.

Social Service Administration

Professors:

LUNDBERG (Nur. 322), MECH

Associate Professors:

CRANMER, ENGELHARDT, HERMAN, HILL,
POLENZ

Assistant Professors:

BANKHEAD, NICHOLS, NUTTALL, RUIZ,
WOODMAN

SW 591 Seminar. Topics offered in specialized areas. Credit, 1-3 hours.

594 Conference and Workshop. Topics offered in specialized areas. Credit, 1-3 hours.

602 Social Services and Policy I. Historical antecedents and current programs designed to meet social needs. Comparative analysis of social welfare services and policy among Western societies. Functions of professions and their evolution in a changing society. Social, political and economic forces affecting development of social services. Credit, 2 hours.

603 Social Services and Policy II. Social welfare problem, policy and provision in the framework of current programs. History of philosophical and social work principles and concepts evaluated and related to Phoenix and Arizona public and private agencies. Credit, 2 hours.

610, 611 Human Behavior and the Social Environment I-II. Normal behavior and social functioning of infant, child, pre-adolescent, adolescent, mature and senescent individual as affected by factors of culture; physical, intellectual, and emotional endowment and development; spiritual involvement; group relationships. Credit, 4 hours first semester, 2 hours second semester.

615 Social Work Methods I. Methodological base of social work practice. Investigations of major areas of knowledge, values and skills basic to social work helping process, whether dealing with individuals, families, nonrelated groups or communities. Credit, 2 hours.

616 Social Work Methods II. Examination of the helping process beginning with identification of a socially problematic situation through steps leading to resolution. Focus on differential use of various solutions to problems in social functioning. Credit, 4 hours.

620 Dynamics of Group Process. Dynamics of groups: roles, ascribed status to members, leadership. Beginning knowledge of theoretical aspects of group behavior. Credit, 2 hours.

630 Social Research. Theory and method in social and behavioral research. Emphasis on problem formulation, hypothesis development, derivation of representative designs and instrument construction. Credit, 2 hours.

631 Practice-Oriented Research. Critical survey of current research literature in selected fields of social work practice. Emphasis placed upon ascribing implications for social work policy and practice. Credit, 2 hours.

640, 641 Field Instruction. Individual instruction, social work practice in a qualified agency: experience in the disciplined use of self in a professional helping relationship. Two consecutive semesters in same agency. Credit, 4 hours each semester.

650 Social Services and Policy III. Agency-focused study of social services and structure in medical, correctional, public school and social welfare agencies. Existing organization patterns contrasted with "ideal." Credit, 2 hours.

651 Social Issues, Problems and Policy. Contemporary social issues, societal problems and relevant present or potential policy. Relationships in social work profession: educationally, in membership associations and to social work practice. Credit, 2 hours.

655 Social Welfare Administration. Administrative structure of social agencies and aspects of social worker's job. Administration as process. Responsibilities in being employee, staff member, agency representative, supervisee, colleague and citizen. Credit, 2 hours.

660, 661 Human Behavior III-IV (Pathology). Knowledge of human behavior and intrapsychic processes originating in various stages of psychosexual development. Deviant behavior related to cultural factors and stress from malfunctioning social systems. Credit, 2 hours each semester.

665 Social Work Methods III. Advanced course in application of principles. Study of practice in context of selected philosophies and theories of change. Examination of solutions to problems. Credit, 2 hours.

666 Social Work Methods IV. Elective seminars directed toward intensive study of practice areas: 1) social work supervision, 2) strategies for individual and family change, 3) social work with nonrelated groups, and 4) strategies for environmental and community change. Credit, 2 hours.

680, 681 Field Research. Concurrent seminar and practicum with emphasis on applications of research strategies to social work practice. Completion of practice-related study required. Students participate in cooperative project or elect individual thesis. Credit, 2 hours each semester.

690 Reading and Conference.

693, 694 Field Instruction. Individual instruction in social work practice, continuing SW 640, 641; a different agency for two consecutive semesters. Credit, 4-5 hours each semester.

729 Educational Aspects of Field Instruction. Educational theory underlying field instruction, normally required of field instructors in their first semester with the school. Prerequisite: Master's degree in social work and instructor's approval. Credit, 2 hours.

Graduate College

WILLIAM J. BURKE, PH.D.

Dean

The development and interpretation of new knowledge and creative work are important functions of the University and matters of specific concern to those involved in the programs available in the Graduate College. For students who have demonstrated a high level of ability and promise at the undergraduate level, graduate work offers an opportunity for further intellectual challenge in advanced and more specialized areas.

The primary purposes of the Graduate College are to provide the student with opportunities for advanced study, and to foster the spirit of scholarship and research. The critical analysis of information and the ability to arrive at a level of understanding beyond that already existing plays an integral role in graduate education.

Under the supervision of the Graduate Council and the Dean of the Graduate College, programs for graduate study are offered by the various departments, schools, centers and colleges. The Graduate Council is responsible for the development and formulation of general policies and the approval of procedures essential to the organization and administration of graduate programs. The Dean of the Graduate College is directly responsible for the administration of policies and graduate programs.

Graduate Degree Programs Offered

Master of Arts
 Master of Science
 Master of Arts in Education
 Master of Business Administration
 Master of Counseling
 Master of Fine Arts
 Master of Music
 Master of Natural Sciences

Master of Public Administration
 Master of Social Work
 Master of Science in Engineering
 Education Specialist
 Juris Doctor
 Doctor of Education
 Doctor of Philosophy
 Doctor of Business Administration

Master of Arts and Master of Science. The master's degree is offered with a major in: Accounting, Agriculture, Anthropology, Art, Biological Sciences, Botany, Chemistry, Drama, Economics, Engineering, English, French, Geography, Geology, German, History, Home Economics, Humanities, Mathematics, Microbiology, Music, Nursing, Philosophy, Physical Education, Physics, Political Science, Psychology, Sociology, Spanish, Speech, Speech Pathology, Technology and Zoology.

Doctor of Philosophy. The Ph.D. degree is offered in the following fields: Anthropology, Botany, Chemistry, Education, Engineering, English, History, Mathematics, Physics, Political Science, Psychology, Spanish and Zoology.

Admission To Graduate College

A student who has earned a bachelor's degree or a graduate degree from an accredited college or university is eligible to apply for admission to the Graduate College of Arizona State University. Application forms may be obtained by writing to the Graduate Admissions Office.

At least two months before the first enrollment, the Graduate College should have received the application for admission and two transcripts of all undergraduate and

graduate work. The transcripts are to be sent directly to the Graduate Admissions Office by the registrar of each college or university which the applicant previously attended. The applicant should write to the registrars concerned and then allow them time to process and mail the transcripts. A qualified applicant, whose application has been filed later than the deadline, may be permitted to enroll in graduate classes as a nondegree student. He will maintain that status until all of the required forms and transcripts have been received and a decision regarding his admission to a program has been reached by the college or department concerned and by the Graduate College.

A student's official status for a semester is determined by his status at the end of that semester.

All documents received by the University in connection with such applications for admission become the property of Arizona State University. Under no circumstances will they be duplicated, returned to the applicant, or forwarded to any agency or other college or university.

Admission to the Graduate College is granted to applicants who have earned a bachelor's or graduate degree from an accredited college or university and who present convincing evidence of their ability to pursue successfully a graduate degree program at Arizona State University. Certain departments require the submission of scores received on the Graduate Record Examination or other predictive examinations. Applicants will be notified of these requirements by the departments. Reports on scores received should be sent directly to the department by the testing service or agency. In all instances, the college or department in which the student wishes to study must indicate its willingness to admit the student. All appli-

cations for admission must be approved by the Dean of the Graduate College. When faculty or facilities are limited, a department may set standards higher than those established by the Graduate College and may recommend denial of a student whose academic record is superior to the minimum requirements described below.

Applicants may be admitted to the Graduate College under three classifications:

Regular Classification. Applicants are ordinarily granted regular admission to the Graduate College if they have achieved a grade point average of "B" (3.0) or better in all work leading to the bachelor's degree and on the recommendation of the department or academic unit in which they plan to study. An applicant may also qualify for admission if his undergraduate overall grade point average is at least 2.5; and in addition, his undergraduate major average is "B" or his average in the last two years of undergraduate work is "B."

Provisional Status. An applicant may be admitted to the Graduate College with provisional status if the department or academic unit in which he plans to study requires additional evidence of his qualification for admission with regular status. No student may maintain provisional status indefinitely. Normally, final determination of status will be made by the time the student has completed 12 hours of approved graduate study. If an applicant has extensive deficiencies requiring an additional year or more of preparatory study, he is ordinarily advised to enroll in an undergraduate program.

Non-Degree Status. An applicant who is not pursuing a graduate degree program may be registered in the Graduate College in a non-degree status. The student is referred to the

Scholarship section regarding the subsequent use of such courses in a degree program.

Foreign Student Admission. Applicants from foreign countries should write to the Graduate Admissions Office at least one year prior to the date they plan to begin study. They will receive the necessary instructions and application blanks which are to be completed and returned to that office. Applicants should make sure that other documents are sent at about the same time, especially transcripts from colleges and universities attended, letters of recommendation, results of the Test of English as a Foreign Language (TOEFL), and a statement of financial responsibility.

Prospective foreign students should not make plans to leave their country until they have received notification of admission. Ordinarily such a statement regarding admission is required before the student can be issued a passport or visa.

Re-Admission to the Graduate College. Any former graduate student who has not been in attendance at Arizona State University for one or more regular semesters must obtain an application for re-admission from the Graduate Admissions Office. This application should be submitted at least one month prior to the beginning of the semester in which the student plans to re-enter. Official transcripts of any additional work taken elsewhere must be sent from the Office of the Registrar at the institution where such credit was earned directly to the Graduate Admissions Office at Arizona State University.

Student Responsibility. It is the responsibility of the graduate student to become conversant with and observe all procedures and requirements of the Graduate College as defined in the *Graduate Bulletin*, and to be familiar

with the University's policy in regard to student conduct as described in the section, "Student Membership in the University," of the *General Catalog*. The student should particularly inform himself about the general regulations concerning the degree he plans to take and any special requirements within his department or academic unit.

Transient Graduate Students. A graduate student in good standing at another university who wishes to earn credits for transfer to that institution may register for a limited number of credit hours either during a summer session or during a regular semester. He will be admitted as a "transient graduate student," and will not be required to submit an academic transcript. A letter from the student's graduate dean, stating that the applicant is in good standing and is authorized to register for specified courses, must be received by the Dean of the Graduate College at least three months prior to registration.

Graduate Study by Arizona State University Faculty Members. A member of the University faculty holding the rank of assistant professor or higher may not earn a graduate degree at Arizona State University. He may, however, be permitted to enroll in graduate courses on a nondegree basis or to take courses for transfer to another institution.

Graduate Credit for Seniors. An Arizona State University senior who is within 12 semester hours of graduation and whose undergraduate work qualifies him for regular admission to the Graduate College, may request permission to register for approved courses for graduate credit. The combined undergraduate and graduate credit load for the semester should not exceed 16 hours. All requests must be approved by the department of academic unit concerned and by

the Dean of the Graduate College. The necessary Senior Permit forms are available at the Graduate College. This approval must be secured at least one month in advance of registration.

Course Load. The course load is determined by the supervisory committee but is not to exceed 15 semester hours of graduate credit. At the graduate level course work, whether or not formal in nature, serves mainly as a guide for independent study. Students are expected to exceed minimum requirements of all kinds and to master subjects rather than simply to pass courses.

Scholarship. Academic excellence is expected of students doing graduate work. A student who is not doing satisfactory work may be withdrawn from the degree program by the Dean of the Graduate College upon the recommendation of the department or academic unit concerned. To be eligible for a degree in the Graduate College, a student must achieve a grade point average of "B" (3.0) or better in all work taken for graduate credit, exclusive of deficiencies, and in all work specifically included in his program of study. Grades below "C" cannot be used to meet the requirements of a graduate degree. Grades on transfer work will not be included in computing grade point averages. Graduate course work, other than research or thesis, reported "Incomplete" must be completed within one year of the official ending of the course. If a grade of "Incomplete" ("I") is not removed within one year, it becomes part of the student's permanent record.

A student receiving a grade of "E" must repeat the course in the regular class if he wishes to include it in his program of study. Both the "E" and the new grade are entered on the student's permanent record.

The mark of "W" is given in a course when-

ever a student (1) officially drops from a course during the first six weeks of the semester; (2) officially withdraws from the University during the first six weeks of the semester; (3) officially drops a course after the first six weeks only if passing at the time of withdrawal; (4) officially withdraws from the University after the first six weeks only if passing at the time of withdrawal.

Up to 10 semester hours of credit toward a master's degree may be earned in extension courses offered by Arizona State University. Students who take graduate extension courses with a view to meeting degree requirements should apply for admission to the master's degree program. Extension courses offered by other universities may not be included in an approved program of study. It should be remembered that not more than 10 semester hours of graduate credit completed before admission to the degree program will be accepted toward a master's degree, and a minimum of 20 semester hours must be completed on campus.

Graduate Credit Courses. Courses carrying graduate credit are numbered 500, 600 and 700. Courses at the 400-level bear graduate credit when taken by graduate students. However, only those courses appearing on the approved program of study may be applied toward a graduate degree.

Graduation. Students should apply for graduation no later than the date specified in the *Graduate Bulletin* calendar. All fees are payable at this time.

Master's Degree

Admission to the Master's Degree Program. Students wishing to enroll in a master's degree program at Arizona State University are admitted according to the procedure

described on pages 249-250. Since graduate work presupposes adequate preparation in a selected field at the undergraduate level, deficiencies will be specified at the time of admission by the department or academic unit involved.

Credit Requirements. A minimum of 30 semester hours of course work approved by the student's supervisory committee and the Graduate College is required. More than 30 semester hours may be required in certain programs.

Supervisory Committee. Upon admission of the applicant with regular or provisional status, a supervisory committee, consisting of a chairman and other members, will be appointed by the Dean of the Graduate College to establish with the student a program of study, to direct his thesis or graduate project, and to administer his final examination(s). Appointments are made by the Dean of the Graduate College on the recommendation of the head of the student's department or academic unit.

Whenever a minor field is involved, one of the members of the committee shall be from the minor field. In the Master of Arts in Education degree programs involving an academic field, the chairman of the supervisory committee shall be from the College of Education and a co-chairman shall be from the academic field. Other members may be from either field.

The designated chairman shall direct the student's thesis study, and the committee shall serve both as a supervisory committee and as an examining committee.

Programs of study for master's degree students shall be filed with the department concerned, and should be used by the supervisory committee and the student in planning future work. Prior to admission to

candidacy, programs of study may be modified as required.

Residence Requirements. A minimum of 20 semester hours of approved graduate work taken on the University campus is required.

Foreign Language Requirement. Language requirements are determined by the department concerned. If a foreign language is required, the student must demonstrate that he possesses a reading knowledge of one of the following languages: French, German, Russian, Spanish. Languages other than these must have the recommendation of the student's supervisory committee and the Dean of the Graduate College.

Foreign language examinations (ETS Examinations) are administered by the University Testing Service. Examinations in languages other than those indicated above are administered by the Department of Foreign Languages. Students planning to take the foreign language examination must register at the University Testing Service at least three weeks prior to the examination date. Only three attempts will be permitted. Satisfactory ETS scores achieved as an undergraduate will be accepted within a six-year time limit. Students who maintained at least a "B" average in the second full year of a language taken at an accredited college or university may petition to be exempt from the test.

The language requirement in French, German or Russian may be fulfilled by special reading courses for graduate students given by the Department of Foreign Languages. Students are certified as having a reading knowledge in a particular language upon completion of the two-semester course, providing a grade "A" or "B" has been achieved in the second semester of the course.

Thesis Requirements. The requirement of a thesis is determined by the department or academic unit concerned. The final copy of the thesis must be reviewed by the student's supervisory committee and submitted to the Dean of the Graduate College at least six weeks before commencement. Copies of *Guide to Thesis Preparation* are available in the Graduate College office.

Candidacy. A student should apply for admission to candidacy and graduation as soon as he has completed 12 hours of graduate work with a grade point average of at least 3.0 in an approved graduate program of study, has removed all listed deficiencies, and has met any foreign language requirements. Changes in the planned program after admission to candidacy must be recommended in writing by the student's supervisory committee and be approved by the Dean of the Graduate College. Application forms for admission to candidacy are available in the graduation section of the Office of the Registrar, 137 Moeur Administration Building.

Final Examinations. A final examination, written, oral or both, administered by the department or academic unit, is required. The dates of the written examinations are set by the Graduate College once each semester and once each summer session, as listed in the *Graduate Bulletin* calendar. A student is not eligible to apply for the comprehensive or any final examination until he has been admitted to candidacy.

Failure in the comprehensive or any final examination will be considered final unless the supervisory committee recommends, and the Dean of the Graduate College approves, a re-examination. Only one re-examination is permitted. At least three months must

earned in extension courses offered by Arizona State University. Extension courses offered by other universities may not be included in an approved program of study.

Maximum Time Limit. All work offered toward a master's degree program must be completed within six consecutive years.

Education Specialist Degree

The Education Specialist degree program is designed to provide opportunity for professional persons in the field of education to develop skills as highly competent practitioners before a re-examination may be scheduled.

The final oral examination in defense of the thesis must be conducted at least three weeks before Commencement. A faculty member, who will be from outside the department, will be appointed by the Graduate Dean for the final oral examination in defense of a thesis. Applications for the final comprehensive examinations are available in the Graduate College office.

Transfer of Credits. A maximum of 6 semester hours of graduate credit taken in other institutions may be transferred for credit toward a master's degree, provided the courses are an acceptable part of the program of study planned by the student's supervisory committee. Such courses must have been taken in an accredited college or university and must be acceptable toward graduate degrees at that institution. Only courses with an "A" or "B" grade may be transferred. Grades on transferred credit cannot be included in the grade point average.

Extension Courses. Up to 10 semester hours of credit toward a master's degree may be

tioners in the various areas of education.

Programs of study for the Education Specialist degree are offered in:

- Adult Education
- Counseling and Student Personnel
- Curriculum and Instruction
- Educational Administration and Supervision
- Elementary Education
- Reading
- Secondary Education
- Social and Philosophical Foundations of Education
- Teaching Specialist

Admission to the Education Specialist Degree Program. To be eligible for admission, the student must have a bachelor's degree from an accredited institution and have at least one year of successful teaching experience. Normally the student will have a master's degree when he enters.

Supervisory Committee. The Dean of the Graduate College, upon recommendation of the department chairman, appoints the supervisory committee. Each area of study included in the degree program will be represented on the committee. The supervisory committee shall approve the program of study, prepare and administer qualifying and comprehensive examinations, approve the applied project, and serve on the final oral examining committee.

Program of Study. Sixty semester hours are required beyond the bachelor's degree. This may include no more than 30 semester hours in a master's degree program. At least 48 hours of course work in the program must be earned in courses at the 500-level or above.

Credits may be transferred from other accredited institutions. The number of credits accepted for transfer will depend upon the objectives approved by the supervisory committee. Grades on transferred credit cannot be included in the grade point average. A minimum of 24 semester hours in the approved program of study shall be taken at Arizona State University, following admission to the program.

Residence. Normally the candidate must expect to spend the equivalent of two full academic years in graduate study, which may include one year spent in attaining the master's degree. One academic semester or a ten-week summer session must be spent in full-time residence at the University before admission to candidacy for the Education Specialist degree. Additional residence may be required by certain departments in order to meet special needs. At least 30 semester hours of approved graduate work must be completed at Arizona State University.

Comprehensive Examinations. When the student has essentially completed the program of study, he will apply to the Graduate College through his supervisory committee for permission to take his oral and written comprehensive examinations. Failure in the comprehensive examinations will be considered final unless the supervisory committee recommends, and the Dean of the Graduate College approves, a re-examination. Only one re-examination is permitted. At least three months must elapse before a re-examination may be scheduled.

Admission to Candidacy. A student should apply for admission to candidacy and graduation promptly after he has completed 45 hours of course work, passed the written and oral comprehensive examinations, and has

had the problem and title of his applied project approved by his supervisory committee.

Applied Project. Upon recommendation of the supervisory committee, a student may enroll for the applied project after completion of 12 hours of approved course work in the degree program.

Final Examination. The final oral examination for the Education Specialist degree program in defense of the applied project report is administered by the supervisory committee and others appointed by the Dean of the Graduate College. This examination is scheduled through the Graduate College and must be held at least three weeks before the commencement date as listed on the *Graduate Bulletin* calendar.

Graduation. After the final oral examination has been passed and the applied project report filed in the office of the Graduate College, the student is eligible for graduation.

Maximum Time Limit. The Education Specialist degree requirements must be completed within three years after the comprehensive examinations have been passed.

Doctor of Philosophy

The Doctor of Philosophy degree is granted upon evidence of high attainment in a special field and demonstration of independent scholarship. Such attainment must be demonstrated by original research or creative work presented in a dissertation. The degree is never conferred solely on the basis of courses completed or formal study extending over a prescribed period of time.

Admission to the Ph.D. Degree Program. The general requirements for admission to the Graduate College are given on page

249. Graduate students in regular classification may apply for admission to the Ph.D. degree program by filing a written application with the Graduate Admissions Office.

Supervisory Committee. Upon recommendation of the department chairman or head of the academic unit, the Dean of the Graduate College appoints the student's supervisory committee, consisting of a chairman and at least four other members.

Program of Study. The program of study should be completed as early as possible and must have the approval of the student's supervisory committee, his department chairman, and the Dean of the Graduate College. The courses may be taken entirely within one department or they may be taken in a combination of departments. Credits from other recognized institutions may be transferred provided the courses meet the objectives of the program as defined by the supervisory committee and are approved by the Graduate Council. Only courses with an "A" or "B" grade may be transferred.

Residence. In general, the Ph.D. degree student should expect to devote to his program of study the equivalent of at least three academic years (84 semester hours) beyond the bachelor's degree. At least two semesters subsequent to the first year (30 semester hours) of graduate study must be spent in continuous full-time residence at Arizona State University, and at least 30 hours of approved graduate credit must be completed at this institution.

Foreign Language Requirements for the Ph.D. Degree. Prior to applying for permission to take the comprehensive examination, and as a condition of admission to candidacy, the student must have demonstrated that he possesses reading knowledge of one of the

following languages: French, German, Russian, Spanish. The individual department determines which of these four languages meet this requirement. Languages other than these must have the recommendation of the student's supervisory committee and the approval of the Graduate Council. A reading knowledge of two or more foreign languages may be required by the individual department.

Foreign language examinations (ETS Examinations) are administered by the University Testing Service. Examinations in languages other than those indicated above are administered by the Department of Foreign Languages. Students planning to take the foreign language examinations must register at the University Testing Service at least three weeks prior to the examination date. Only three attempts will be permitted. Satisfactory ETS scores achieved as an undergraduate will be accepted within a six-year time limit. Students who maintained at least a "B" average in the second full year of a language taken at an accredited college or university may petition to be exempt from the test.

The language requirement in French, German or Russian may be fulfilled by special reading courses for graduate students given by the Department of Foreign Languages. Students are certified as having a reading knowledge in a particular language upon completion of the two-semester course, providing a grade of "A" or "B" has been achieved in the second semester of the course.

Comprehensive Examinations. When a student has essentially completed the course work in an approved program of study and has satisfied the foreign language requirements, he should request permission from the Graduate College to take his comprehensive examinations. These written and oral exam-

inations are designed to test the student's mastery of his field of specialization. Failure in the comprehensive examinations will be considered final unless the supervisory committee recommends, and the Dean of the Graduate College approves, a re-examination. At least three months must elapse before a re-examination may be scheduled. Only one re-examination is permissible.

Admission to Candidacy. The student should apply promptly for admission to candidacy and for graduation after he has passed the comprehensive examinations and has had the subject problem and title of his dissertation approved by his supervisory committee.

Research and Dissertation. Each candidate will register for a minimum of 24 semester hours credit for research and dissertation. The final copy of the dissertation must be reviewed by the supervisory committee and the Dean of the Graduate College at least six weeks before commencement. Copies of *Guide to Thesis Preparation* are available in the Graduate College office.

Final Examination. The final oral examination in defense of the dissertation will be scheduled by the Dean of the Graduate College. This examination may not be scheduled earlier than three weeks after the completed dissertation has been reviewed by the supervisory committee and the Dean of the Graduate College. The examination will be conducted by the supervisory committee and others appointed by the Dean of the Graduate College. All final oral examinations must be conducted at least three weeks before commencement.

Graduation. After the final oral examination has been passed and the dissertation has been accepted and filed in the Graduate College, the student is eligible for graduation.

Maximum Time Limit. The candidate must take the final oral examination in defense of the dissertation within five years after passing the comprehensive examinations. Any exception must be approved by the supervisory committee and the Graduate Council and ordinarily will involve repetition of the comprehensive examinations.

Doctor of Education

The basic purpose of the Doctor of Education degree program is to provide opportunity for those interested in the field of education to do advanced scholarly study and research in preparation for professional practice. A dissertation based upon this research is required. The degree is never conferred solely as a result of study extending over any prescribed period of time or the completion of a given number of courses. The program for the Doctor of Education degree requires at least the equivalent of three academic years of full-time study beyond the bachelor's degree or two academic years of full-time study beyond the master's degree.

The Doctor of Education degree is offered in the following areas:

- Adult Education
- Art Education
- Business Education
- Counseling and Student Personnel
- Curriculum and Instruction
- Educational Administration and Supervision
- Educational Technology
- Elementary Education
- Health and Physical Education
- Industrial Education

- Mathematics Education
- Music Education
- Physics Education
- Science Education
- Secondary Education
- Social and Philosophical Foundations of Education

Admission to the Doctor of Education Degree Program. A student who seeks admission normally will be expected to have a master's degree. An applicant may be required to take special qualifying examinations prepared and evaluated by the graduate committee of the department to which he applies. The general requirements for admission to the Graduate College are given on pages 249-250.

Supervisory Committee. The Dean of the Graduate College upon recommendation of the department chairman appoints the supervisory committee. Each area of study included in the degree program will be represented on the committee.

Program of Study. A minimum of 90 semester hours of work taken beyond the bachelor's degree is required. At least 28 semester hours of course work must be taken in Education, exclusive of the dissertation.

Upon approval of the supervisory committee, the student may start research activity in connection with the dissertation after he has completed 15 hours of work in the program beyond the master's level.

Credit may be granted for courses taken at other recognized institutions. The number of credits accepted on transfer depends upon the recommendation of the supervisory committee and approval of the Graduate Council. Only courses with "A" or "B" grades may be transferred.

Residence. The candidate should expect to spend the equivalent of three full academic years in graduate study, which may include one year spent in attaining the master's degree. The amount of time a student must spend in official residence on the campus depends to some extent on his individual program of studies. However, he must satisfy a minimum residence requirement of 30 semester hours within a period of 18 consecutive months, including a maximum of 10 semester hours for research and dissertation credit. Additional residence may be required by certain departments in order to meet special needs.

Comprehensive Examinations. When the student has essentially completed the program of study and has passed his foreign language examinations, if required, he will apply to the Graduate College through his supervisory committee for permission to take his written and oral comprehensive examinations. These examinations are prepared, administered and evaluated by the supervisory committee. Failure in the comprehensive examinations will be considered final unless the supervisory committee recommends, and the Dean of the Graduate College approves, a re-examination. Only one re-examination is permissible. At least three months must elapse before re-examination may be scheduled.

Admission to Candidacy. The student should apply for admission to candidacy promptly after he has passed the written and oral comprehensive examinations and after the subject of his dissertation has been approved by his supervisory committee.

Research and Dissertation. Each candidate will register for a minimum of 24 semester hours credit for research and dissertation. The final copy of the dissertation must be

reviewed by the supervisory committee and the Dean of the Graduate College at least six weeks before commencement. Copies of *Guide to Thesis Preparation* are available in the Graduate College office.

Final Examination. The final oral examination in defense of the dissertation will be scheduled by the Dean of the Graduate College. This examination will be conducted by the supervisory committee and others appointed by the Dean of the Graduate College. The final oral examination must be held at least three weeks before commencement.

Graduation. After the final oral examination has been passed and the dissertation has been accepted and filed in the Graduate College, the student is eligible for graduation. He must apply for graduation through the Office of the Registrar.

Maximum Time Limit. All requirements for the Doctor of Education degree must be completed within five years after the first of the comprehensive examinations has been passed.

Doctor of Business Administration Degree

The primary objectives of the Doctor of Business Administration degree are to prepare persons for teaching and research in institutions of higher learning, and to develop proficiency for effective service in a leadership capacity in either private business or government. The degree is granted upon the completion of high academic attainment in graduate study, an original research project presented in a dissertation, and comprehensive written and oral examinations.

The D.B.A. degree program is designed to

provide a broad study of the interrelated areas of business administration and a high degree of professional competence in three fields of specialization.

Admission to the D.B.A. Degree Program.

A student applies for admission to the D.B.A. degree program by filing a written application with the Graduate Admissions Office. The application is considered by the Graduate Committee of the College of Business Administration in consultation with the academic department of the applicant's major field and a recommendation is then made to the Dean of the Graduate College. Admission is based upon the applicant's entire record. The Admission Test for Graduate Study in Business is required, together with three letters of recommendation.

A student normally completes a master's degree or equivalent before entering the D.B.A. degree program. In an exceptional case, a candidate with a bachelor's degree may be admitted, in which case he shall complete the requirements of the master's degree program before pursuing the doctoral core and specialized fields.

A student who applies for admission to the program without all of the business core courses required by the American Association of Collegiate Schools of Business for admission to graduate study in business may be admitted provisionally until all business core courses are satisfactorily completed. Currently core courses include basic work in each of the following seven areas: accounting, economics, finance, management, marketing, statistics and business law.

Supervisory Committee. The Dean of the Graduate College, upon recommendation of the Dean of the College of Business Administration, appoints a supervisory committee of five faculty members. The chairman is

selected from the student's field of concentration, two members are selected from the student's supplementary fields, and two members are selected at large from the faculty of the College of Business Administration. The supervisory committee approves the program of study, guides the student through his entire period of study, and serves on his examining committee for the general oral examination.

Program of Study. The program is planned to fit the student's background and objectives. The degree is granted upon evidence of demonstrated competency and scholarly achievement, rather than upon the accumulation of hours in a series of prescribed courses. A minimum of 30 semester hours of credit beyond the master's degree is required of all doctoral students, exclusive of the dissertation and the prerequisite business courses generally required by the American Association of Collegiate Schools of Business for admission to graduate study in business. For most students the program will consist of 36 to 54 semester hours beyond the master's degree, depending on the student's academic background.

Reading knowledge of a foreign language is not required for the D.B.A. degree.

Residence. The entire program, including course work and dissertation, normally requires at least the equivalent of two academic years of work beyond a master's degree. Students must spend at least one academic year of the last two years (summer sessions excluded) in full-time course work in residence. The dissertation may be completed in absentia with permission of the student's supervisory committee and the Dean of the College of Business Administration.

Comprehensive Examinations. During the final semester of course work, the student must apply to the Graduate College through the supervisory committee for permission to take his comprehensive written examinations. Examinations are required in the field of concentration and each supplementary field and are designed to test the student's comprehensive knowledge of the fields rather than the subject matter of specific courses taken. Comprehensive written examinations must be taken in two consecutive sittings. If a student does not pass a written comprehensive examination, he must file a revised program of study which normally reflects prescribed additional formal course work. He must also complete the course work before permission for a second examination will be granted. Upon satisfactory completion of all course work and comprehensive written examinations, the student must complete a general oral examination which covers the entire doctoral program, except the dissertation. For either written or oral examinations, only one re-examination is permitted. At least three months must elapse before a re-examination may be scheduled.

Admission to Candidacy. A student applies for candidacy when he has completed his general oral examination and has a dissertation subject submitted to and approved by his dissertation committee. If a candidate fails to complete his dissertation oral examination within five years after completing his comprehensive examinations, it will be necessary for him to be re-admitted to candidacy.

Dissertation. The dissertation requires major research of an original and creative nature. The final copy of the dissertation must be reviewed by the committee appointed to

direct the dissertation research and also by the Dean of the Graduate College at least six weeks before commencement. General rules of the Graduate College for dissertation procedures, format, and microfilming will be followed. Copies of *Guide to Thesis Preparation* are available in the Graduate College office.

Dissertation Oral Examination. The final oral examination in defense of the dissertation will be scheduled by the Dean of the Graduate College. All final oral examinations must be conducted at least three weeks before commencement. The candidate will present and defend his dissertation before members of his dissertation committee and others appointed by the Dean of the Graduate College at a meeting open to all faculty members.

Graduation. After the dissertation is officially accepted and the final oral examination passed, the candidate may apply for graduation through the Graduate College office prior to the required date listed in the *Graduate Bulletin* calendar.

General Regulations. In all matters not specified above, the standard procedures established by the Graduate College for the Ph.D. degree will apply.

University Extension and Summer Sessions

DENIS J. KIGIN, Ed.D.

Dean and Director

University Extension

The opportunity for continuing education is offered through University Extension. The following services are provided: correspondence study, extension classes at various off-campus sites and community services.

Correspondence Study. The services of certain teaching faculty and departments are extended through the mails. College credit correspondence courses offered by Arizona State University are specifically designed for the student who cannot attend classes on campus. They are offered for those who are seeking to fulfill some degree objective as well as for those who wish to increase their occupational, professional or intellectual skills.

A correspondence course consists of eight lesson assignments for each semester hour of credit and generally requires the same amount of work as the course taken in residence. Eight to ten hours will normally be required in preparing each assignment.

Persons desiring to enroll in correspondence study should write to the Correspondence Study Office, University Extension, for an enrollment form and a brochure listing the courses available. The fee for correspondence courses is \$16.00 per semester hour of credit. Students who fail a course on campus or through University Extension are not permitted to make up the deficiency by correspondence study. No student doing work in residence may register for a course by correspondence without first obtaining approval of the Standards Committee of the college in which the student is enrolled. Students are limited to a maximum of two courses (six credit hours) taken at one time.

A maximum of 30 semester hours of credit

earned in correspondence and/or by comprehensive examination may be applied toward the baccalaureate degree at Arizona State University. Correspondence courses are not applicable as graduate credit toward advanced degrees.

Extension Classes. Extension classes are organized where there is sufficient demand, when qualified instructors are available, and when library or laboratory facilities are adequate to provide university-level instruction. Two types of programs are available: (1) University credit courses that serve in part to meet degree requirements at the undergraduate and graduate level, and (2) informal noncredit educational experiences for personal growth, general cultural advancement, refresher training and the acquisition of new interests. Conferences, institutes and seminars are scheduled to meet the needs of the community and the university.

Extension courses may be applied toward bachelor's or advanced degree requirements. A maximum of 10 semester hours of credit earned in extension courses may be applied toward a master's degree at Arizona State University.

The fee for extension courses is \$16.00 per semester hour, and is payable at the time of registration. For further information write the Office of University Extension, Arizona State University.

Center for Community Services. The Center for Community Services is an agency of Arizona State University designed to bring the resources of the University — its faculty, staff, students and facilities — to bear on the problems of the disadvantaged. Administered through University Extension, the center is designed to assist other community agencies and individuals in developing and



coordinating programs which are dedicated to eliminating poverty and social injustices.

Summer Sessions

The Summer Sessions provide a flexible alternative for those who seek to complete degree requirements in less than the normal four-year period.

The opportunities for study are much the same as those of the academic year. Although the number of courses offered is not as extensive as during the academic year, a broad selection is available for both graduate and undergraduate students, as well as for those seeking to enhance or to refresh their subject matter interest. All classes are held in air-conditioned classrooms and laboratories. The opportunity for foreign travel and study is available during the summer through selected study tours. The tours are directed by regular faculty members and allow students to earn undergraduate or graduate credit. All summer programs are available to residents of the State of Arizona as well as to those from out-of-state. Professional conferences, institutes, workshops and seminars are also offered on campus during the Summer Sessions.

Terms. The Summer Sessions consist of two terms of five weeks each.

Credit and Residence Requirements. Students are permitted to earn a maximum of 6 semester hours of credit each five-week session. Under certain circumstances it is possible for a student to satisfy the University residence requirement by attending Summer Sessions. Students entering as freshmen from high school are invited to begin their university work in the summer.

Enrollment. In general, applicants for admission are expected to present evidence of graduation from an approved four-year high school, or evidence of good standing in an accredited college. Mature students, over 21 years of age, are admitted without the above qualifications, but with the understanding that all admission requirements must be satisfied before they can become candidates for the bachelor's degree.

Graduate Study. Summer Sessions offers an excellent opportunity for those who have already acquired a bachelor's degree to do graduate work for personal edification or to work for advanced degrees.

Fees and Expenses. The Summer Sessions fee is \$18.00 per semester hour, in addition to a \$3.50 student activity fee. Textbooks and supplies are available for purchase at the University Bookstore on campus. Board and room for the summer are available on campus at the prevailing rates.

Information. Requests for the Summer Sessions Schedule of Courses or for other information should be addressed to the Office of Summer Sessions at Arizona State University.

Faculty, University Offices and Services

Arizona Board of Regents

EX OFFICIO

Jack Williams *Governor of Arizona*
W. P. Shofstall, B.S. in Ed., M.A., Ph.D.
Superintendent of Public Instruction

APPOINTED

Term Expires

John A. Lentz, B.S.M.E. *January, 1973*
Norman G. Sharber *January, 1973*
Margaret M. Christy *January, 1975*
Paul L. Singer, B.S., M.D., F.A.C.S. *January, 1975*
Gordon D. Paris *January, 1977*
James Elliott Dunseath, J.D. *January, 1977*
Kenneth G. Bentson *January, 1979*
Sidney S. Woods, B.S. *January, 1979*
Thomas L. Hall, B.A., LL.B. *Advisor to the Board*
Myron R. Holbert, A.B., M.A. *Budget Officer for the Board*

Arizona State University Administration

John W. Schwada, Ph.D. *President of the University*
Karl H. Dannenfeldt, Ph.D. *Academic Vice President*
George F. Hamm, Ph.D. *Vice President,*
Student Affairs; Dean of Students
William J. Burke, Ph.D. *Vice President,*
Graduate Studies; Dean, Graduate College
Gilbert L. Cady, B.A. in Ed. *Vice President, Business Affairs*

General Administration

John W. Schwada *President of the University;*
Professor of Political Science
B.S., Northeast Missouri State College; M.A., University of Missouri;
Ph.D., University of Texas
Karl H. Dannenfeldt *Academic Vice President;*
Professor of History
A.B., Valparaiso University; M.A., Indiana University;
Ph.D., University of Chicago

George F. Hamm, Ph.D. *Vice President, Student Affairs;*
Dean of Students; Associate Professor of Education
 B.S., South Dakota State College; M.A., Ph.D., University of Wyoming

William J. Burke *Vice President, Graduate Studies;*
Dean, Graduate College; Professor of Chemistry
 A.B., Ph.D., Ohio State University

Gilbert L. Cady *Vice President, Business Affairs*
 B.A. in Ed., Arizona State University

George A. Peek, Jr. *Dean, College of Liberal Arts;*
Professor of Political Science
 B.A., M.A., Ph.D., University of Virginia

James W. Elmore *Dean, College of Architecture;*
Professor of Architecture
 A.B., University of Nebraska; M.S. in Architecture, Columbia University

Glenn D. Overman *Dean, College of Business Administration;*
Professor of Business Administration
 B.S., Central State College; M.S., Oklahoma State University;
 D.B.A., Indiana University

Delbert D. Weber *Dean, College of Education;*
Professor of Education
 B.A., Midland College; M.Ed., Ed.D., University of Nebraska

Lee P. Thompson *Dean, College of Engineering Sciences;*
Director, School of Engineering; Professor of Engineering
 B.A., Indiana University; M.S., Ph.D., Texas A&M University

Henry A. Bruinsma *Dean, College of Fine Arts; Professor of Music*
 B.M., M.M., Ph.D., University of Michigan

Willard H. Pedrick *Dean, College of Law; Professor of Law*
 B.A., Parsons College; J.D., Northwestern University

Horace W. Lundberg *Dean, Graduate School of Social Service*
Administration; Professor of Social Work
 B.S., M.S., University of Utah; M.S.W., University of California, Berkeley;
 Ph.D., University of Minnesota

. *Dean, College of Nursing; Professor of Nursing*

Denis J. Kigin *Dean, University Extension;*
Director, Summer Sessions; Professor, Industrial Technology
 B.S., Mankato State Teachers College; M.S., The Stout Institute;
 Ed.D., University of Missouri

Troy F. Crowder *Assistant to the President; Director, University*
Relations; Associate Professor, Mass Communications
 B.A., University of South Dakota; M.A., State University of Iowa

William H. Axford *University Librarian; Professor*
 A.B., Reed College; M.A., Ph.D., University of Denver

Alfred Thomas, Jr. *Registrar and Director of Admissions*
 B.A. in Ed., M.A. in Ed., Arizona State University

. *Director of Intercollegiate Athletics;*
Professor of Health, Physical Education, and Recreation

Resident Faculty

Abbott, John C. (1956) *Associate Professor of Education*
 B.S., M.S., Ed.D., Indiana University

Abdow, Miriam J. (1965) *Instructor in French*
 M.A., University of Paris (France)

Abraham, Willard (1953) *Professor of Education;*
Chairman, Department of Special Education
 B.S., Illinois Institute of Technology; M.Ed., Chicago Teachers College;
 Ph.D., Northwestern University

Acevedo, Roberto M. (1964) *Assistant Professor of Spanish*
 A.B., University of California, Berkeley; M.A., University of Arizona

Acker, William J. (1970) *Associate Professor of Geography*
 B.S., Purdue University; M.A., Ph.D., Syracuse University

Adams, Vaughn P., Jr. (1968) . . *Assistant Professor of Industrial Design*
 B.S., M.S., Arizona State University

Adams, Wallace E. (1958) *Professor of History*
 B.S., M.A., University of Oregon; Ph.D., Stanford University

Ahmadzadeh, Akbar (1966) *Associate Professor of Physics*
 B.A., Ph.D., University of California, Berkeley

Alarcón, Justo S. (1968) *Assistant Professor of Spanish*
 B.A., M.A., (Theol.), Serafica (Spain); M.A. (Social Sc.), Laval University
 (Canada); M.A. (Spanish), Arizona State University

Aldrich, Frank T. (1969) *Assistant Professor of Geography*
 B.A., University of Texas; M.S., Ph.D., Oregon State University

Alisky, Marvin (1957) *Professor of Political Science;*
Director of Center for Latin American Studies
 B.A., M.J., Ph.D., University of Texas

Allen, Theodore, Jr. (1959) *Professor of Engineering*
 B.S.M.E., M.S.M.E., Texas A & M University

Alpher, Barry J. (1968) *Assistant Professor of Anthropology*
 B.A., University of Chicago

Anderson, Bruce A. (1966) *Assistant Professor of Mathematics*
 B.A., M.S., Ph.D., University of Iowa

Anderson, Ethel (1966) *Assistant Professor of Education;*
Counselor, University Counseling Service
 B.S., Utah State University; M.Ed., Ed.D., University of Wyoming

Anderson, Melvin S. (1967) *Associate Professor of Real Estate*
 B.S., M.S., Oklahoma State University; M.Ed., Ed.D., University of Wyoming

- Anderson, William (1969) *Associate Professor of Sociology*
B.A., University of Akron; M.A., Kent State University;
Ph.D., Ohio State University
- Apilado, Vincent P. (1969) *Assistant Professor of Finance*
B.S., University of Portland; M.B.A., University of Oregon;
Ph.D., University of Michigan
- Archer, Jerome W. (1963) *Professor of English*
B.A., M.A., Marquette University; Ph.D., Northwestern University
- Archibald, Bruce R., SP/5, (1970) *Assistant Professor of Military Science*
- Armstrong, Donald R., Major (1969) *Assistant Professor*
B.S., Iowa State College
of Military Science
- Armstrong, Robert L. (1967) *Assistant Professor of Education*
B.A., State Teachers College of Iowa; M.S., State University of Iowa;
Ed.D., University of Arizona
- Arner, Douglas G. (1959) *Professor of Philosophy;*
Chairman, Department of Philosophy
B.S., Creighton University; M.A., Ph.D., University of Michigan
- Aronson, Jerome M. (1966) *Professor of Botany*
B.A., Ph.D., University of California, Berkeley
- Arson, Stephen R. (1970) *Assistant Professor of Psychology*
B.S., Pennsylvania State University; M.A., Ph.D., University of Connecticut
- Ashe, Robert W. (1955) *Professor of Education*
A.B., M.A., in Ed., Arizona State University;
Ed.D., University of Southern California
- Atsumi, Takayori (1968) *Assistant Professor of Music*
B.M.A., Kunitachi Music College (Japan);
M.M., New England Conservatory of Music
- Austin, John A. (1971) *Assistant Professor of Engineering*
B.S., Louisiana Polytechnic Institute; M.A., Ph.D., Arizona State University
- Autenrieth, Bertha (1946) *Professor Emeritus of Music*
B.M., New England Conservatory; M.M., University of Michigan
- Autore, Donald D. (1959) *Assistant Professor of Engineering*
B.S.E., University of Michigan; M.S.E., Arizona State University
- Avery, James P. (1960) *Professor of Engineering*
B.S.M.E., M.S.E.M., University of Michigan; Ph.D., Purdue University
- Ax, Leland S. (1959) *Associate Professor of Engineering*
B.S.E.E., B.S.R.E., Tri-State College; M.S., Kansas State College
- Bachman, Betty J. (1969) *Assistant Professor*
of Health, Physical Education and Recreation
B.S. (Nursing), M.P.H., University of California, Los Angeles
- Backus, Charles E. (1968) *Associate Professor of Engineering*
B.S.M.E., Ohio University; M.S., Ph.D., University of Arizona
- Badler, Leland (1970) *Professor of Law;*
Director of Institute of Legal Resources
A.B., N.Y.U., University College; J.D., Columbia University
- Bagley, Weldon D. (1961) *Instructor in Technology*
B.S., Utah State University
- Bahr, Donald M. (1967) *Assistant Professor of Anthropology*
A.B., Ph.D., Harvard University
- Baker, Donald H. (1965) *Instructor in Health, Physical Education*
and Recreation; Assistant Football Coach
B.S., M.A., North Texas State University
- Baker, Georgianne R. (1971) . . *Assistant Professor in Home Economics*
B.S., Marygrove College; M.S., Ohio State University;
Ph.D., Michigan State University
- Baker, Virgil B. (1966) *Professor of Geography*
B.S., M.S., University of Nebraska; Ph.D., University of Utah
- Baldwin, Mary A. (1969) *Instructor in English*
B.A., M.A., Arizona State University
- Ball, Rachel S. (1947) *Professor Emeritus of Psychology*
A.B., University of Missouri; Ph.D., University of Chicago
- Ballew, Thomas J. (1967) *Assistant Professor of Architecture*
B.S., University of Oklahoma
- Bamford, Larry R. (1969) *Assistant Professor of Industrial Design*
B.A., M.A., University of Iowa
- Bankhead, Marilyn J. (1969) *Assistant Professor of Social Work*
B.A., M.S.W., Arizona State University
- Bardrick, Richard A. (1956) *Associate Professor of Psychology*
A.B., Ph.D., University of California, Los Angeles
- Barkley, Margaret V. (1963) *Professor of Home Economics;*
Supervisor for State Department of Education
B.S., Millikin University; M.S., Ed.D., University of Illinois
- Barkson, Joseph A. (1958) *Professor of Engineering*
B.S.E.E., University of Michigan; M.S., Ph.D., University of Illinois
- Barlow, Richard B. (1965) *Professor of History*
B.A., M.A., Ph.D., University of Pennsylvania
- Barnes, Norman L., LTC (1968) . . *Assistant Professor of Military Science*
A.B., College of William and Mary
- Baroody, Wilson G. (1957) *Assistant Professor of English*
B.A., Grand Canyon College; M.A., University of Arizona
- Barrett, Thomas W. (1950) *Professor of Agronomy*
B.S., Brigham Young University; M.S., Ph.D., Cornell University
- Bartel, Carl R. (1968) *Professor of Technical Education*
B.S., M.S., Kansas State College of Pittsburg; Ed.D., University of Missouri

- Bartz, Donna R. (1968) *Assistant Professor of Speech and Theatre*
B.F.A., M.A., University of Colorado
- Bassford, Gerald (1969) *Assistant Professor of Management*
B.S., M.S., University of Wyoming; D.B.A., Indiana University
- Bateman, George M. (1927) *Professor Emeritus of Chemistry*
B.S., Utah State University; M.S., Ph.D., Cornell University
- Bates, F. Kathleen (1964) *Assistant Professor of Home Economics*
B.S., State University of New York; M.S., Drexel Institute of Technology
- Baty, Wayne M. (1962) *Professor of Business Administration*
B.S. in Ed., Southwest Missouri State College; M.A., Northwestern University;
Ph.D., University of Southern California
- Baumann, Victor H. (1964) *Professor of Education*
B.A., Grinnell College; M.A., Northwestern University;
Ed.D., University of Southern California
- Baxter, Robert J. (1966) *Instructor, Quantitative Systems;*
Coordinator of Student Advisement
B.S., Central Missouri State College; M.A., Arizona State University
- Beakley, George C., Jr. (1956) *Professor of Engineering;*
Associate Dean, College of Engineering Sciences;
Director, Engineering Science Program
B.S.M.E., Texas Technological College; M.S.M.E., University of Texas;
Ph.D., Oklahoma State University
- Beauchamp, Ramar K., Capt. (1968) *Assistant Professor*
A.B., San Jose State College *of Military Science*
- Becker, R. James (1965) *Professor of Agricultural Economics*
B.S., M.A., Bradley University; Ph.D., University of Illinois
- Becker, Walter G. (1955) *Associate Professor of Finance*
A.B., M.A., Loyola University; Ph.D., State University of Iowa; C.F.A.
- Bedient, Jack D. (1963) *Associate Professor of Mathematics*
A.B., Albion College; M.B.S., Ed.D., University of Colorado
- Bedworth, David D. (1963) *Professor of Engineering*
B.S. in I.E., Lamar College of Technology; M.S. in I.E., Ph.D., Purdue University
- Bell, James W. (1966) *Associate Professor of Education*
A.B., Washburn University; M.Ed., Ed.D., University of Kansas
- Bell, John E. (1965) *Associate Professor of Education*
B.S., University of Nebraska; M.A., Ed.D., University of Wyoming
- Bell, Mary E. (1970) *Associate Professor of Education*
B.S., Indiana State Teachers College; M.S., Butler University;
Ed.D., Indiana University
- Belok, Michael V. (1959) *Professor of Education*
B.S., Indiana University; M.A., Arizona State University;
Ph.D., University of Southern California
- Bender, Gordon L. (1953) *Professor of Zoology*
B.S., Iowa State College; M.S., University of Wisconsin;
Ph.D., University of Illinois
- Benedict, Joel A. (1946) *Professor of Education;*
Director, Audiovisual Services
B.A., M.A., Arizona State University; Ed.D., Stanford University
- Benin, David B. (1970) *Assistant Professor of Physics*
A.B., Cornell University; M.A., Ph.D., University of Rochester
- Bennett, ElDean (1970) *Assistant Professor of Mass Communications*
B.A., Brigham Young University; M.A., Ph.D., Michigan State University
- Benzinger, Robert P. (1970) *Associate Professor of Industrial Design*
B.S.M.E., University of Wisconsin; M.A.E., Chrysler Institute of Engineering
- Berch, Michael A. (1969) *Professor of Law*
B.A., LL.B., Columbia University
- Berman, David R. (1966) *Assistant Professor of Political Science*
B.A., Rockford College; M.A., Ph.D., American University
- Berman, Neil S. (1964) *Professor of Engineering*
B.S., University of Wisconsin; M.S., M.A., Ph.D., University of Texas
- Bershad, David L. (1970) *Assistant Professor of Art*
A.B., Stanford University; Ph.D., University of California, Los Angeles
- Bertelson, Wendle R. (1964) *Assistant Professor of Architecture*
B.Arch., University of Michigan
- Bertke, Eldridge M. (1958) *Professor of Zoology*
B.S., M.S., Ph.D., University of Wisconsin
- Bessom, Richard M. (1968) *Associate Professor of Marketing*
B.A., Cornell University; M.B.A., Stanford University;
D.B.A., University of Washington
- Betz, Mathew J., III (1961) *Professor of Engineering;*
Associate Dean, Graduate College
B.S., M.S., Ph.D., Northwestern University
- Bickford, William B. (1966) *Associate Professor of Engineering*
B.S., M.S., Kansas State University; Ph.D., University of Illinois
- Bieber, Allan L. (1963) *Associate Professor of Chemistry*
B.S., M.S., North Dakota State University; Ph.D., Oregon State University
- Bigelow, John G., Capt. (1970) *Assistant Professor of Military Science*
B.A., Arizona State University
- Biggerstaff, Donald R. (1969) *Instructor in English*
B.A., University of Houston; M.A., Trinity University
- Bininger, Robert J. (1962) *Professor of Spanish;*
Assistant Dean, College of Liberal Arts
B.A., Ph.D., Ohio State University
- Bitter, Gary G. (1970) *Assistant Professor of Education*
B.S., Kansas State University; M.A., Kansas State Teachers College;
Ph.D., University of Denver

- Blackham, Garth (1962) *Professor of Education*
B.S., M.S., Utah State University; Ph.D., Cornell University
- Blackledge, Vernon O. (1969) *Assistant Professor of Engineering*
B.S.E.E., University of Illinois; M.S.E.E., University of Santa Clara;
Ph.D., Arizona State University
- Blaesser, Willard W. (1968) *Professor of Education*
B.S., M.A., University of Wisconsin; Ed.D., George Washington University
- Blewett, Laura J. (1964) *Assistant Professor of Nursing*
B.S., University of Minnesota; M.S., Western Reserve University
- Bloemendaal, Nancy L. (1970) *Instructor in Music*
B.A., Arizona State University
- Blumer, Cynthia S. (1970) *Instructor in English*
B.A., University of Wichita; M.A., Arizona State University
- Boetto, Laurel B. (1956) *Assistant Professor of Education*
B.A. in Ed., M.A. in Ed., Arizona State University
- Bogart, Quentin J. (1970) *Associate Professor of Education*
B.A., M.S., Ft. Hays Kansas State College; Ph.D., University of Texas, Austin
- Boggs, Lohnie J. (1959-65; 1966) *Professor of Office Administration
and Business Education; Chairman,
Department of Administrative Services*
B.S., M.A., Ph.D., Ohio State University
- Bohlman, Herbert M. (1964) *Associate Professor of
Business Administration*
B.S. in B.A., Drake University; M.B.A., J.D., Indiana University
- Bond, M. E. (1967) *Associate Professor of Economics;
Director, Bureau of Business
and Economic Research*
B.B.A., M.A., Ph.D., State University of Iowa
- Bontrager, O. R. (1962) *Professor Emeritus of Education*
B.S., M.A., Ph.D., State University of Iowa
- Borgo, Philip E. (1967) *Instructor in Engineering*
B.S., University of Cincinnati
- Bowers, Charles O. (1948) *Associate Professor of Music*
B.S. in Ed., Southeast Missouri State College;
M.M., D.M.A., Eastman School of Music
- Bowersock, Dave E., Major (1969) *Assistant Professor of Military Science*
A.B., University of Wichita
- Bowman, Russell K. (1956) *Professor of Romance Languages*
A.B., A.M., Ph.D., Columbia University
- Boyd, Gertrude A. (1958) *Professor of Education*
A.B., M.S., Florida State University; Ed.D., Colorado State College
- Boyle, Bernard M. (1969) *Associate Professor of Architecture*
B.Arch., University of Sydney (Australia);
M.Arch., M.A., Ph.D., Yale University
- Brand, Mark (1968) *Instructor in Social Work*
B.A., M.A., University of Arizona; M.S.W., University of California, Berkeley
- Brannon, Bettye W. (1970) *Instructor in Social Work*
B.A., Texas Technological College; M.S.W., Arizona State University
- Branstetter, Ellamae (1958-65; 1967) *Professor of Nursing*
R.N., Jewish Hospital; B.S., St. Louis University; M.P.H., University
of Minnesota; Ph.D., University of Chicago
- Braver, Sanford L. (1970) *Assistant Professor of Psychology*
B.A., Wayne State University; Ph.D., University of Michigan
- Breckenridge, Jack D. (1962) *Professor of Art*
B.S., Wisconsin State College; M.F.A., State University of Iowa
- Bredehoft, Theodore C. (1962) *Instructor in Health, Physical
Education and Recreation; Administrative Assistant
to the Athletic Director; Wrestling Coach*
B.S., Cornell College; M.S., University of Washington
- Bregar, John F. (1965) *Associate Professor of Engineering*
B.S., Pennsylvania State University; Ph.D., University of Arizona
- Bresina, Bertha M. (1960) *Professor of Home Economics;
Chairman, Department of Home Economics*
B.S., M.S., Stout State College; Ph.D., Iowa State University
- Bria, Janet L. (1967) *Instructor in English*
B.A., Pennsylvania State University; M.A., Arizona State University
- Britton, Mervin W. (1957) *Associate Professor of Music*
B.S., M.S., University of Illinois
- Britz, Richard D. (1969) *Instructor in Architecture*
B.Arch., University of Kansas
- Broadley, Hugh T. (1969) *Professor of Art*
A.B., Park College; M.A., Yale University; Ph.D., New York University
- Broekema, Andrew J. (1968) *Professor of Music;
Chairman, Department of Music*
B.M., M.M., University of Michigan; Ph.D., University of Texas
- Brook, Weston L. (1966) *Associate Professor of Education*
B.A., M.A., Ed.D., University of Wyoming
- Brose, Marianna F. (1963) *Assistant Professor of English*
B.A., College of William and Mary; M.A., Arizona State University
- Brouch, Virginia B. (1965) *Assistant Professor of Art*
B.A., College of St. Francis; M.A., Ed.D., Arizona State University
- Brown, Alan R. (1968) *Associate Professor of Education*
B.A., M.A., Los Angeles State College; Ph.D., University of Texas
- Brown, Donald E. (1963) *Professor of Mass Communications*
B.A., M.A., State University of Iowa
- Brown, Duane (1951) *Professor of Chemistry*
B.S., Brigham Young University; Ph.D., Cornell University

- Brown, Peter (1967) *Associate Professor of Chemistry*
B.S., Ph.D., University of Southampton (England)
- Brown, Theodore M. (1963) *Associate Professor of Chemistry*
B.S., M.S., University of Toledo; Ph.D., Iowa State University
- Brown, Walter C. (1966) ... *Professor of Industrial Technical Education;*
Associate Director, Division of Technology
B.S., Northwest Missouri State College; M.Ed., Ed.D., University of Missouri
- Bruinsma, Henry A. (1964) *Professor of Music;*
Dean, College of Fine Arts
B.M., M.M., Ph.D., University of Michigan
- Bruner, May I. (1961) *Associate Professor of Nursing*
B.S., University of Hawaii; M.S., University of Colorado
- Bryant, Fred O. (1950) *Associate Professor of Health,*
Physical Education and Recreation
B.S., Springfield College; M.S., University of Illinois;
Ed.D., Arizona State University
- Buchly, Howard L., Capt. (1969) . *Assistant Professor of Military Science*
B.A., University of Colorado
- Buckingham, Willis J. (1969) *Assistant Professor of English*
A.B., Harvard College; M.S., University of Wisconsin; Ph.D., Indiana University
- Bucknor-Smartt, Mary F. (1970) *Instructor in English*
B.A., M.A., Arizona State University
- Buffington, Albert F. (1965) *Professor of German*
A.B., Bucknell University; A.M., Ph.D., Harvard University
- Bullock, Arnold H. (1941) *Professor of Music*
B.M., Yale University; M.A. in Ed., Arizona State University
- Bunt, Lucas N. H. (1968) *Professor of Mathematics*
Ph.D., University of Groningen (Netherlands)
- Buntz, Barbara B. (1968) *Instructor in Home Economics*
B.S., University of Illinois; M.S., Arizona State University
- Burdette, Walter E. (1956) .. *Professor of Industrial Technical Education;*
Director, Division of Technology
B.S., M.S., Kansas State College of Pittsburg; Ed.D., University of Missouri
- Burg, B. Richard (1967) *Assistant Professor of History*
B.A., University of Colorado; M.A., Western State College of Colorado;
Ph.D., University of Colorado
- Burgess, Paul L. (1969) *Assistant Professor of Economics;*
Research Associate, Bureau of Business and Economic Research
B.A., Ph.D., University of Colorado
- Burgoyne, Edward E. (1951) *Professor of Chemistry*
B.S., Utah State University; M.S., Ph.D., University of Wisconsin
- Burk, Karl W. (1949) *Assistant Professor*
of Industrial Technical Education
B.A. in Ed., M.A. in Ed., Arizona State University; Ed.D., Bradley University
- Burke, William J. (1962) *Professor of Chemistry;*
Vice President for Graduate Studies; Dean, Graduate College
A.B., Ph.D., Ohio State University
- Burkhard, Samuel (1921) *Professor Emeritus of Education*
B.A., Goshen College; M.A., Columbia University; Ph.D., New York University
- Burnett, Joanne M. (1967-68; 1971) *Assistant Professor of Nursing*
R.N., Good Samaritan Hospital School of Nursing; B.S.N., Arizona
State University; M.S., University of California, San Francisco
- Burton, Arleigh R. (1941) *Professor of Accounting*
A.B., M.A., Emporia State Teachers College; Ph.D., University of
Nebraska; C.P.A., Arizona
- Burton, Foster M. (1969) *Associate Professor of Construction*
B.S.C.E., B.S. (Industrial Management), Carnegie Institute of Technology;
M.B.A., New York University
- Buseck, Peter R. (1963) .. *Associate Professor of Chemistry and Geology*
B.A., Antioch College; M.A., Ph.D., Columbia University
- Byers, Nellie B. (1934-41; 1947) *Associate Professor of Education*
B.A., University of Cincinnati; M.A., Ohio State University
- Cabianca, William A. (1967) *Associate Professor of Education*
B.Ed., Gonzaga University; M.Ed., Ph.D., Washington State University
- Campbell, Roy H. (1965) *Associate Professor of Marketing*
M.B.A., University of Chicago; Ph.D., Columbia University
- Canby, William C., Jr. (1967) *Professor of Law*
B.A., Yale University; LL.B., University of Minnesota
- Canright, James E. (1964) *Professor of Botany; Chairman,*
Department of Botany and Microbiology
B.A., Miami University; A.M., Ph.D., Harvard University
- Capps, Julian M. (1969) *Assistant Professor of Aerospace Studies*
B.A., North Carolina State College; M.S. in Ed., University of Southern California
- Cardona, Lannie D., Capt. (1970) *Assistant Professor*
of Military Science
B.S., Sam Houston State College
- Carlson, Ingeborg L. (1965) *Associate Professor of German*
Ph.D., University of Erlangen (Germany)
- Carney, James D. (1967) *Professor of Philosophy*
M.A., Roosevelt University; Ph.D., University of Nebraska
- Carr, Alice R. (1955) *Associate Professor of Mathematics*
A.B., St. Mary's College; M.A., Ohio University
- Carroll, Christina (1966) *Associate Professor of Music*
- Carver, George L. (1965) *Assistant Professor of Classical Languages*
B.A., M.A., University of Texas; S.T.B., St. Mary's Seminary,
Baltimore; Ph.D., St. Louis University

- Case, James L. (1969) *Assistant Professor of Speech and Theatre*
B.S., Weber State College; M.S., Ph.D., University of Utah
- Castillo, Senon A. (1951) *Instructor in Health,
Physical Education and Recreation; Track Coach*
B.S. in Ed., Arizona State University
- Castle, Gordon B. (1962) *Professor of Zoology*
B.A., Wabash College; M.A., Ph.D., University of California, Berkeley
- Caughey, Winslow S. (1969) *Professor of Chemistry*
B.S., M.S., University of New Hampshire; Ph.D., Johns Hopkins University
- Cavalliere, William A. (1947) *Assistant Professor of Technology*
B.A. in Ed., M.A. in Ed., Arizona State University
- Cazier, Mont A. (1962) *Professor of Zoology*
B.S., Ph.D., University of California, Berkeley
- Chafey, Kathleen H. (1967) *Assistant Professor of Nursing*
B.S., Arizona State University; M.S., University of Minnesota
- Chamberlain, S. Burt (1967) *Instructor in Social Work*
B.S., M.S.W., University of Utah
- Chambers, Anthony (1971) *Assistant Professor of Japanese*
B.A., Pomona College; M.A., Stanford University
- Chartier, George M. (1970) *Assistant Professor of Psychology*
B.S., University of Illinois; M.A., Ph.D., University of Oregon
- Chasey, Eugene F. (1965) *Associate Professor of Education*
B.S., Northwestern State College; M.A., Colorado State College;
Ed.D., University of Wyoming
- Chen, Stanley S. H. (1967) *Associate Professor of Engineering*
Diploma, Taipei Institute of Technology (China); M.S., Ohio University;
Ph.D., University of Wisconsin
- Chilton, Ernest G. (1969) *Professor of Mechanical Engineering*
S.B., Massachusetts Institute of Technology; M.S., California Institute
of Technology; Ph.D., Stanford University
- Christiansen, Kent M. (1966) *Associate Professor of Education;
Coordinator of Student Advisement*
B.S., M.S., Brigham Young University; Ph.D., Michigan State University
- Christine, Ray Orr (1958) *Associate Professor of Education*
A.B., A.M., Colorado State College; Ed.D., Arizona State University
- Chu, Roland F., SFC (1968) *Assistant Professor of Military Science*
- Church, Kathleen K. (1969) *Assistant Professor of Zoology*
B.S., M.A., University of Utah; Ph.D., University of California, Berkeley
- Churchill, William D. (1966) *Assistant Professor of Education;
Counselor, University Counseling Service*
A.B., Colgate University; M.Ed., Alfred University; Ed.D., University of Rochester
- Clark, Geoffrey A. (1971) *Assistant Professor of Anthropology*
B.A., M.A., University of Arizona; Ph.D., University of Chicago
- Clark, Michal C. (1970) *Assistant Professor of Education*
B.A., University of California, Los Angeles; Ph.D., Stanford University
- Clark, Wilburn O. (1967) *Associate Professor of Engineering*
B.S., M.S., Ph.D., University of Kansas
- Cleary, Edward W. (1967) *Professor of Law*
A.B., Illinois College; J.D., University of Illinois; J.S.D., Yale University
- Cleary, Ruth B. (1969) *Instructor in Nursing*
R.N., Misericordia Hospital School of Nursing; B.S.N., Boston College
School of Nursing; M.S., Boston College Graduate School
- Clements, Sallee M. (1969) *Instructor in English*
B.A., M.A., Arizona State University
- Clothier, Ronald R. (1955) *Associate Professor of Zoology*
A.B., Fresno State College; M.A., University of Montana;
Ph.D., University of New Mexico
- Cluff, Gordon L. (1963) *Associate Professor of Speech and Theatre*
B.A., Arizona State University; M.S., Ph.D., Southern Illinois University
- Cochran, Douglas L. (1968) *Associate Professor
of Business Administration*
B.S., Ohio State University; M.B.A., Harvard University;
D.B.A., University of Oregon
- Cochran, John A. (1962) *Professor of Economics*
A.B., Drake University; A.M., Ph.D., Harvard University
- Cohen, David (1967) *Associate Professor of Music*
B.S., M.S., Juilliard School of Music; D.M.A., University of Southern California
- Cohen, Naomi W. (1968) *Assistant Professor of Education*
B.A., M.A., Ed.D., Arizona State University
- Cohen, Warren H. (1968) *Assistant Professor of Law*
A.B., Yale University; J.D., Harvard University
- Colby, Arthur L. (1965) *Assistant Professor of English*
B.A., University of Massachusetts; M.A., Ph.D., University of North Carolina
- Cole, Gerald A. (1959) *Professor of Zoology*
A.B., Middlebury College; M.S., St. Lawrence University;
Ph.D., University of Minnesota
- Collins, Jack A. (1963) *Associate Professor of Engineering*
B.M.E., M.S., Ph.D., Ohio State University
- Comeaux, Malcolm L. (1969) *Assistant Professor of Geography*
B.A., University of Southwestern Louisiana; M.A., Southern Illinois
University; Ph.D., Louisiana State University
- Conlin, David A. (1948) *Professor Emeritus of English*
A.B., Syracuse University; Ph.D., Yale University
- Cook, Jeffrey M. (1961) *Associate Professor of Architecture*
B.Arch., University of Manitoba (Canada); M.Arch., Pratt Institute

RESIDENT FACULTY

- Cook, Phil A. (1963) *Associate Professor of Education*
B.A., Southwestern State College; M.A., Colorado State College of Education;
Ed.D., University of Kansas
- Corliss, Charlotte N. (1964) *Assistant Professor of Nursing*
R.N., Western Pennsylvania Hospital School of Nursing; B.S. in Nur. Ed.,
University of Pittsburgh; M.Ed., University of Minnesota
- Corona, Dorothy F. (1964) *Associate Professor of Nursing*
B.S., Whitworth College; M.N., M.S.N., Western Reserve University
- Corrie, John B. (1970) *Assistant Professor of Architecture*
A.A., Diploma, Architectural Association School, London;
M.C.P., Massachusetts Institute of Technology
- Couch, Sanford C. (1962) *Associate Professor of Russian*
B.A., M.A., Ph.D., University of Wisconsin
- Cowley, John M. (1969) *Galvin Professor of Physics*
B.S., M.S., University of Adelaide (Australia); Ph.D., Massachusetts
Institute of Technology; D.Sc., University of Adelaide (Australia)
- Cox, Steven R. (1970) *Assistant Professor of Economics*
B.S., University of Wisconsin; M.A., University of Michigan
- Craig, Samuel E. Jr. (1960) *Professor of Engineering*
B.S., Oregon State University; Ph.D., University of Utah
- Cranmer, William H. (1963) *Associate Professor of Social Work*
B.A., University of Akron; M.S., Western Reserve University
- Creighton, Judith M. (1967) *Instructor in Home Economics*
B.S., University of Arizona; M.S., Arizona State University
- Cronin, John R. (1966) *Assistant Professor of Chemistry*
B.A., College of Wooster; Ph.D., University of Colorado
- Crooks, Lois I. (1959) *Instructor in English*
B.A., Ottawa University (Canada); M.A., University of Missouri
- Crouch, Beulah (1953) *Assistant Professor of Education*
B.A. in Ed., M.A. in Ed., Arizona State University
- Crowder, Troy F. (1970) .. *Associate Professor of Mass Communications;*
Assistant to the President; Director, University Relations
B.A., University of South Dakota; M.A., State University of Iowa
- Cummings, Lawrence T. (1970) *Associate Professor of Education;*
Director, University Counseling Service
B.A. in Ed., M.A. in Ed., Arizona State University;
Ed.D., University of California, Los Angeles
- Cummings, Susan N. (1964) *Assistant Professor of Education*
B.S., University of Chicago; M.A. in Ed., Ed.D., Arizona State University
- Cunningham, William R. (1970) *Instructor in Home Economics*
B.S., M.S., Brigham Young University
- Curran, Mark J. (1968) *Assistant Professor of Spanish*
B.S., Rockhurst College; Ph.D., St. Louis University
- Daane, Calvin J. (1963) *Professor of Education*
B.S., University of Wisconsin; M.A., Teachers College, Columbia University;
Ed.D., Indiana University
- Dahl, Richard C. (1966) *Professor of Law; Director of Law Library*
B.A., B.L.S., University of California, Berkeley; LL.B., Catholic University
- Dales, L. Richard (1966) *Associate Professor of Music*
B.M., University of Louisville; M.M., Indiana University
- Dalgleish, Donald D. (1962) .. *Assistant Professor of Political Science*
B.A., Carleton College; A.M., Columbia University; Ph.D., University of Colorado
- Daly, Thomas B., LTC (1969) .. *Assistant Professor of Military Science*
B. of G.E., University of Omaha; M.S., Troy State University
- D'Angelo, Frank J. (1970) *Assistant Professor of English;*
Director, Freshman English
B.A., Loyola University of New Orleans; M.A., Tulane University of Nebraska
- Daniel, Norman E. (1970) *Associate Professor*
of Business Administration
B.S., M.S., University of Tennessee; Ph.D., Indiana University
- Dannenfeldt, Karl H. (1956) *Professor of History;*
Academic Vice President
A.B., Valparaiso University; M.A., Indiana University;
Ph.D., University of Chicago
- Dauten, Joel J. (1960) *Professor of Finance;*
Chairman, General Business Administration Department
B.S., M.S., Washington University; Ph.D., State University of Iowa
- Davis, Keith (1958) *Professor of Management*
B.B.A., M.B.A., University of Texas; Ph.D., Ohio State University
- Davis, Robert E. (1959) *Associate Professor of Speech and Theatre*
A.B., A.M., Ph.D., University of Illinois
- Davis, Sandford S. (1953) *Professor of Education*
A.B., B.S., Central Missouri State College; A.M., University of Missouri;
Ed.D., University of Colorado
- Deach, Dorothy F. (1967) *Professor of Health,*
Physical Education and Recreation
B.S., M.S., Ph.D., University of Illinois
- Decker, John P. (1963) *Professor of Engineering*
B.S., University of Idaho; M.A., Ph.D., Duke University
- Deever, R. Merwin (1959) *Professor of Education;*
Director, Bureau of Educational Research and Services
A.B., Southwestern College; Ed.M., Ed.D., University of Oklahoma
- Demand, Marian F. (1966) *Assistant Professor of Music*
B.S., Central Missouri State College; M.M., Northwestern University;
D.M.A., University of Southern California
- DeMassa, Thomas A. (1966) *Associate Professor of Engineering*
B.S.E., M.S.E., M.S., Ph.D., University of Michigan

- Demeke, Howard J. (1962) *Associate Professor of Education*
 A.B., San Francisco State College; M.S., Ed.D., University of Southern California
- Dezelsky, Thomas L. (1968) *Associate Professor of Health,
 Physical Education and Recreation*
 B.S., Central Michigan University; A.M., University of Michigan;
 H.S.D., Indiana University
- Dickens, Paul F., III (1970) *Assistant Professor of Economics*
 B.A., University of Virginia; M.A., Michigan State University
- Dillow, Paul V. (1968) *Assistant Professor of Psychology*
 B.S., Durham University (England); Ph.D., University of Tennessee
- Ditsworth, Richard L. (1959) *Associate Professor of Engineering*
 B.S., M.S., Iowa State College; Ph.D., Michigan State University
- Dittert, Alfred E., Jr. (1967) *Professor of Anthropology*
 B.A., M.A., University of New Mexico; Ph.D. University of Arizona
- Dix, George E. (1968) *Associate Professor of Law*
 B.S., J.D., University of Wisconsin
- Dobkin, William E. (1970) . . . *Assistant Professor of Speech and Theatre*
 B.A., Eastern Michigan University; M.A., University of Colorado;
 Ph.D., Indiana University
- Doebler, John W. (1970) *Associate Professor of English*
 B.A., Duke University; M.A., Ph.D., University of Wisconsin
- Donelson, Kenneth L. (1965) *Professor of English*
 B.A., M.A., Ph.D., State University of Iowa
- Donnelly, Aaron V. (1962) *Professor of Engineering*
 B.S. in E.E., M.S., State University of Iowa; M.A., Columbia University;
 Ph.D., State University of Iowa
- Dorson, William J. (1966) *Professor of Engineering*
 B.Ch.E., M.Ch.E., Rensselaer Polytechnic Institute;
 Ph.D., University of Cincinnati
- Downing, George D., Jr. (1964) *Professor of Marketing*
 B.S. in E.E., Iowa State College; D.B.A., Michigan State University
- Doyle, Donald P. (1962) *Associate Professor of Speech and Theatre*
 B.A., Arizona State University; M.A., Northwestern University
- Doyle, Roy P. (1959) *Professor of Education;
 Associate Dean, College of Education*
 B.A. in Ed., Arizona State University; M.A., Ed.D., Columbia University
- Dresskell, Nadine (1946) *Associate Professor of Music*
 B.S., Bowling Green State University; M.A., Teachers College, Columbia University
- Dudek, Leona M. (1960) *Assistant Professor of Education*
 B.Ed., National College of Education; M.A. in Ed., Arizona State University
- Dudley, Guilford A. (1956) *Professor of History;
 Director, Center for Asian Studies*
 A.B., Harvard University; M.A., Ph.D., University of California, Los Angeles
- Durrenberger, Robert W. (1971) *Professor of Geography*
 B.S., Moorhead State College; B.S., California Institute of Technology;
 M.S., University of Wisconsin; Ph.D., University of California, Los Angeles
- Dycus, Augustus M. (1959) *Associate Professor of Botany*
 B.S., Akron University; Ph.D., Cornell University
- Eck, Roger D. (1970) *Assistant Professor of Quantitative Systems*
 B.S.Ch.E., Clarkson College of Technology; M.B.A., University of New Mexico
- Edwards, John L. (1964) *Associate Professor of Education*
 B.S., Ball State University; M.A., Ed.D., Arizona State University
- Edwards, Marvin J. (1959) *Assistant Professor of Technology*
 B.S., M.A. in Ed., Arizona State University
- Effland, Richard W. (1967) *Professor of Law*
 B.A., LL.B., University of Wisconsin; LL.M., Columbia University
- Eidenschink, Leo J., MSG (1970) . . *Assistant Professor of Military Science*
- Eilers, John A. (1967) *Assistant Professor of Political Science*
 B.A., Lafayette College; M.A., University of Maryland
- Ekmanis, Rolf (1963) *Associate Professor of Russian*
 B.A., M.A., University of Wisconsin; Ph.D., Indiana University
- Ellis, Carleen R. (1967) *Assistant Professor of Nursing*
 R.N., West Suburban Hospital School for Nurses; B.S.N., Wheaton College;
 M.S.N., University of Colorado
- Ellis, John C. (1957) *Associate Professor of English*
 B.A., M.A., Ph.D., University of Oregon
- Ellis, Robert H. (1962) . . *Associate Professor of Mass Communications;
 Director, Bureau of Broadcasting*
 B.A., Arizona State University; M.A., Western Reserve University
- Ellner, Anthony, Jr. (1960) *Professor of Architecture*
 B.A., Brooklyn College; B. Arch., Yale University; M.A., Columbia University
- Ellsworth, Lola (1938) *Professor of Home Economics*
 B.S., Brigham Young University; M.A. Teachers College, Columbia University
- Elmore, James W. (1949) *Professor of Architecture;
 Dean, College of Architecture*
 A.B., University of Nebraska; M.S. in Arch., Columbia University
- Elsa, Janet G. (1970) *Assistant Professor of Speech and Theatre*
 B.A., M.A., University of California, Davis
- Emery, Raymond C. (1962) *Associate Professor of English*
 B.A., M.A., University of Wyoming; Ed.D., Stanford University
- Engelhardt, Florence P. (1965) *Associate Professor of Social Work;
 Coordinator of Field Instruction*
 B.A., College of Mount Saint Vincent; M.S.S., Fordham University School of Social Service
- English, William S. (1962) *Professor of Music*
 B.M., Washburn University; M.A., Ph.D., Peabody College

- Erno, Richard B. (1957-62; 1963) *Professor of English*
B.A., Michigan State University; M.A., University of Denver;
Ph.D., University of Minnesota
- Escudero, Mary J. (1948) *Professor of Spanish*
A.B., San Diego State College; M.A., Claremont College;
Diplome, Institut de Phonetique-University of Paris (France);
Ph.D., Cornell University
- Evans, Donovan L. (1966) *Associate Professor of Engineering*
B.S.M.E., University of Cincinnati; Ph.D., Northwestern University
- Evans, John X. (1964) *Associate Professor of English*
B.A., Holy Cross College; M.A., Ph.D., Yale University
- Eyring, LeRoy (1961) *Professor of Chemistry*
B.S., University of Arizona; Ph.D., University of California, Berkeley
- Faas, Larry A. (1967) *Associate Professor of Education*
B.S., Iowa State College; M.A., Colorado State College;
Ed.D., Utah State University
- Fahlgren, George W. (1966) *Assistant Professor
of Business Administration*
B.A., State University of Iowa; J.D., Northwestern University
- Farmer, Frank D. (1970) *Assistant Professor of Mathematics*
B.A., M.A., University of California, Riverside; Ph.D., University of Washington
- Farness, Sherly F. (1969) *Assistant Professor of Art*
B.A., M.A., Michigan State University
- Farris, Martin T. (1957) *Professor of Economics*
B.A., M.A., University of Montana; Ph.D., Ohio State University
- Fausel, Donald F. (1969) *Assistant Professor of Sociology*
A.B., S.T.B., St. Mary's University; M.S.W., Fordham University
- Fearon, Harold E. (1961) *Professor of Management;
Chairman, Department of Management*
B.S., M.B.A., Indiana University; Ph.D., Michigan State University
- Feldstein, Alan (1970) *Associate Professor of Mathematics*
B.A., Arizona State University; Ph.D., University of California, Los Angeles
- Ferrell, Donald M. (1970) *Assistant Professor of Mass Communications*
B.A., San Diego State College; M.A., University of Missouri
- Ferrell, Wilfred A. (1959) *Professor of English;
Chairman, Department of English*
B.A., M.A., Ph.D., University of Texas, Austin
- Fetterhoff, Willard M. (1965) *Associate Professor of Education*
B.Ed., Illinois State University; M.A., University of Arizona;
Ed.D., University of Denver
- Finch, Alice J. (1965) *Assistant Professor of Nursing*
R.N., Lutheran Hospital School for Nurses; B.N.S., Augustana College;
M.S., University of Colorado
- Fink, Raymond R. (1958) *Professor of Art*
B.A.E., School of Art Institute of Chicago;
M.S.A.E., Institute of Design, Illinois Institute of Technology
- Firestone, Melvin (1968) *Associate Professor of Anthropology*
B.A., University of New Mexico; M.A., Ph.D., University of Washington
- Fisher, D. Jerome (1968) *Professor of Geology*
B.S., M.S., Ph.D., University of Chicago
- Fisher, Marvin M. (1958) *Professor of English*
A.B., A. M., Wayne State University; Ph.D., University of Minnesota
- Fletcher, Grant (1956) *Professor of Music*
B.M., Illinois Wesleyan University; M.M., University of Michigan;
Ph.D., Eastman School of Music
- Florschuetz, Leon W. (1964) *Associate Professor of Engineering*
B.S., M.S., Ph.D., University of Illinois
- Flynn, James T. (1964) *Associate Professor of Architecture*
B.Arch., Carnegie Institute of Technology; M.Arch., Harvard University
- Foster, David W. (1966) *Professor of Spanish*
B.A., M.A., Ph.D., University of Washington
- Fouquette, Martin J., Jr. (1965) *Associate Professor of Zoology*
B.A., M.A., Ph.D., University of Texas
- Frame, Terry M. (1968) *Assistant Professor of Office Administration
and Business Education; Coordinator of Office Education*
B.S., Northern Illinois University; M.S., University of Colorado
- Frasier, James E. (1963) *Professor of Education*
B.A., Colorado State College; M.A., University of Michigan;
Ed.D., Colorado State College
- Frederickson, Michael, SGT. (1970) *Assistant Professor
of Military Science*
- Freund, John E. (1957) *Professor of Mathematics*
B.A., M.A., University of California, Los Angeles;
Ph.D., University of Pittsburgh
- Friedman, Lawrence J. (1968) *Assistant Professor of History*
A.B., University of California, Riverside;
M.A., Ph.D., University of California, Los Angeles
- Frost, Melvin J. (1965) *Assistant Professor of Geography*
B.S., Arizona State University; M.S., Brigham Young University;
Ph.D., University of Florida
- Fry, Harold (1958) *Associate Professor of Engineering*
B.S., Colorado State University; M.E., University of Wyoming;
M.S., University of Colorado
- Fry, Maurine A. (1967) *Associate Professor of Education*
B.S., M.A., University of South Dakota; Ph.D., State University of Iowa
- Fuchs, Jacob (1951) *Professor of Chemistry*
B.A., New York University; M.S., Ph.D., University of Illinois

- Fuller, Robert W. (1968) *Instructor in English*
B.A., M.A., Arizona State University
- Fullerton, Bill J. (1958) *Professor of Education;*
Director, Professional Field Experiences
B.S., Northwestern State College; Ed.M., D.Ed., University of Oklahoma
- Fullinwider, S. Pendleton (1967) *Associate Professor of History*
B.S., U.S. Naval Academy; M.S., Ph.D., University of Wisconsin
- Furnish, Dale B. (1970) *Associate Professor of Law*
B.A., Grinnell College; J.D., State University of Iowa
- Gable, William R. (1967) *Professor of Political Science;*
Director, Institute of Public Administration
A.B., A.M., Louisiana State University; Ph.D., University of Chicago
- Gaffney, Philip D. (1957) *Professor of Education*
B.S., Northern Illinois State College; M.A., Ph.D., State University of Iowa
- Galbraith, Gary G. (1970) *Associate Professor of Psychology*
B.A., Southern Illinois University; M.A., Ph.D., Ohio State University
- Gelinas, Wilfrid E., Major (1969) *Assistant Professor*
of Military Science
B.S., United States Naval Academy; M.S., Arizona State University
- Gelopulos, Demos P. (1968) *Associate Professor of Engineering*
B.S.E.E., Valparaiso University; M.S.E.E., University of Notre Dame;
Ph.D., University of Arizona
- Gerking, Shelby D. (1967) *Professor of Zoology;*
Chairman, Department of Zoology
A.B., DePauw University; Ph.D., Indiana University
- Gerlach, Vernon S. (1963) *Professor of Education; Chairman,*
Department of Educational Technology and Library Science
B.A., Wayne State University; M.A., University of Minnesota;
Ed.D., Arizona State University
- Gersten, Charles D. (1964) *Associate Professor of Psychology*
B.B.A., City College of New York; Ph.D., Florida State University
- Gibbs, Robert T. (1970) *Assistant Professor of Art*
B.A., Loras College; M.A., M.F.A., University of Iowa
- Gieschen, Donald W. (1959) *Associate Professor of Philosophy*
B.S., Northwestern University; M.A., Ph.D., University of Minnesota
- Giffin, Frederick C. (1967) *Associate Professor of History;*
Assistant Dean, Graduate College
B.A., Denison University; M.A., Ph.D., Emory University
- Gill, George A. (1967) *Assistant Professor of Education*
B.S., M.A., Arizona State University
- Gisolo, Margaret (1954) *Associate Professor of Health,*
Physical Education and Recreation
B.S., Indiana State Teachers College; M.A., New York University
- Glotfelty, JoAnn (1970) *Assistant Professor of Social Work*
B.A., Northwestern University; M.S. in S.S., Boston University
- Goheen, Douglas-Scott (1965) *Assistant Professor of Speech*
and Theatre
A.B., College of William and Mary; M.F.A., Yale University
- Goldstein, Myron (1963) *Assistant Professor of Mathematics*
B.S., M.A., Ph.D., University of California, Los Angeles
- Goo, Benjamin (1955) *Professor of Art*
B.F.A., State University of Iowa; M.F.A., Cranbrook Academy of Art
- Gooding, Elmer R. (1967) *Assistant Professor of Economics;*
Assistant Dean and Director of Graduate Studies,
College of Business Administration
B.S., McPherson College; M.A., Ph.D., University of Kansas
- Gordon, Leonard (1967) *Assistant Professor of Sociology*
B.A., Wayne State University; A.M., University of Michigan;
Ph.D., Wayne State University
- Gourley, David R. (1967) *Assistant Professor of Marketing*
B.S., Miami University; M.B.A., University of Toledo; D.B.A., Indiana University
- Grace, Edward E. (1963) *Professor of Mathematics*
B.S., Ph.D., University of North Carolina
- Gravell, Joan (1970) *Instructor in Social Work*
B.A., University of Texas; M.A., University of Chicago
- Green, James L. (1967) *Assistant Professor of English*
B.A., M.A., University of Kansas
- Green, Mary E. (1967) *Assistant Professor of English*
B.A., Queens College, New York; M.A., St. John's University, New York;
Ph.D., University of Chicago
- Greene, Mildred S. (1966) *Assistant Professor of English*
A.B., Wellesley College; M.A.T., Radcliffe College;
M.A., University of Massachusetts; Ph.D., University of New Mexico
- Greey, George W. (1969) *Associate Professor of Health,*
Physical Education and Recreation; Coordinator,
University Recreation
B.A., M.A., Purdue University; Ph.D., University of Michigan
- Grier, Marvin (1957) *Assistant Professor of Health,*
Physical Education and Recreation; Supervisor of Swimming Pool
B.S., Wisconsin State College; M.A., New York University
- Griffith, LeRoy H. (1958) *Professor of Education*
B.S. in Ed., M.S. in Ed., Drake University; Ph.D., State University of Iowa
- Grigsby, J. Eugene (1966) *Associate Professor of Art*
A.B., Morehouse College; M.A., Ohio State University;
Ph.D., New York University
- Grimes, John O. (1928) *Professor Emeritus of Psychology*
B.S., in Ed., Ohio University; M.A., Ph.D., University of Michigan

- Grobe, Edwin P. (1957) *Professor of French*
A.B., William Jewell College; M.A., Ph.D., Indiana University
- Gross, Douglas R. (1968) *Associate Professor of Education*
B.S., M.A., Western Michigan University; Ph.D., University of Wisconsin
- Grossman, Louis H. (1966) *Professor of Marketing*
A.B., University of Michigan; M.B.A., Ph.D., Michigan State University
- Gryder, Robert (1959-63; 1964) *Associate Professor
of Office Administration and Business Education*
B.S., Northwestern State College; M.Ed., Louisiana State University;
E.Ed., University of North Dakota
- Guillot, Ellen E. (1964) *Professor of Sociology*
B.S., Simmons College; M.A., Ph.D., University of Pennsylvania
- Guinouard, Donald E. (1966) *Associate Professor of Education;
Counselor, University Counseling Service*
B.S., M.S., Montana State College; Ed.D., Washington State University
- Gurnee, Herbert L. (1943) *Professor Emeritus of Psychology*
A.B., M.A., Wesleyan University; Ph.D., Harvard University
- Gwinner, Robert F. (1970) *Professor of Marketing;
Chairman, Department of Marketing*
B.S., University of Southern Mississippi; M.B.A., Ph.D., University of Arkansas
- Haberman, Donald C. (1967) *Associate Professor of English*
B.A., Rutgers, The State University; M.A., Ph.D., Yale University
- Hadley, Neil F. (1966) *Associate Professor of Zoology*
B.A., Eastern Michigan University; Ph.D., University of Colorado
- Hagan, Alfred J. (1970) .. *Assistant Professor of Business Administration*
B.A., University of Maine; M.B.A., Indiana University;
Ph.D., University of Texas, Austin
- Haggerson, Nelson L. (1961-63; 1964) *Professor of Education;
Chairman, Department of Secondary Education*
B.A., Vanderbilt University; M.S., in Ed., New Mexico Western College;
Ph.D., Claremont Graduate School
- Hahn, Arthur W. (1962) *Assistant Professor of Art*
B.F.A., California School of Fine Arts; M.A., San Francisco State College
- Hakac, John (1966) *Assistant Professor of English*
A.B., Centre College of Kentucky; M.A., Ph.D., University of Texas
- Hale, John Douglas (1956) *Associate Professor of Art*
B.F.A., M.F.A., University of Southern California; Ph.D., Ohio State University
- Hamm, George F. (1962) *Associate Professor of Education;
Vice President for Student Affairs; Dean of Students*
B.S., South Dakota State College; M.A., Ph.D., University of Wyoming
- Hanna, A. Lyle (1967) *Associate Professor of Music*
B.M., College of Music of Cincinnati; Ph.D., Indiana University
- Hansen, Marie E. (1971) *Instructor in Nursing*
R.N., Trinity Hospital School of Nursing; B.S.N., M.S., Montana State University
- Hansen, Theodore C. (1966) *Instructor in Music*
B.M., University of Colorado; M.M., Arizona State University
- Hanson, Hugh (1948) *Professor of Zoology*
B.S., in Ed., Kansas State Teachers College; M.S., Ph.D., University of Illinois
- Hanson, Roland C. (1966) *Associate Professor of Physics*
B.S., Michigan College of Mining and Technology;
M.S., Ph.D., University of Illinois
- Hardert, Ronald A. (1966) *Assistant Professor of Sociology*
A.B., M.A., University of Cincinnati; Ph.D., Indiana University
- Hardt, Annabelle (1968) *Associate Professor of Education*
B.A., Southwestern University; A.M., Cornell University;
Ph.D., University of Texas
- Harged, Andrew A. (1969) *Assistant Professor of Accounting*
B.A., Hastings College; M.A.S., Ph.D., University of Illinois;
C.P.A., Illinois, North Carolina
- Haring, L. Lloyd (1959) *Professor of Geography*
B.S. in Ed., M.S., Kansas State Teachers College; Ph.D., State University of Iowa
- Haroldson, Bruce O. (1967) *Instructor in Health, Physical
Education and Recreation; Assistant Basketball Coach*
B.S., Augustana College; M.Ed., University of Oregon
- Harris, Brice (1962) *Professor Emeritus of English*
B.A., Erskine College; M.A., Vanderbilt University; Ph.D., Harvard University
- Harris, Kathryn M. (1965) *Instructor in English*
B.A., M.A., Arizona State University
- Harris, William H. (1960) *Professor of Marketing*
B.S., University of Denver; M.B.A., Ph.D., Ohio State University
- Harrison, William J. (1966) *Assistant Professor of French*
M.A., University of Chicago
- Harter, Tom J. (1937) *Professor of Art*
B.A. in Ed., Arizona State University; M.F.A., University of Oregon
- Harward, Naomi (1956) *Professor of Sociology*
B.D., Garrett Biblical Institute; B.A., Northwestern University;
M.A. (Rel. Ed.), M.A. (Social Welfare), University of Chicago
- Hasbrouck, Frank F. (1962) *Associate Professor of Zoology*
B.A., Ph.D., University of Illinois
- Hassett, Matthew J. (1966) *Associate Professor of Mathematics*
B.A., Fordham University; M.S., Ph.D., Rutgers, The State University
- Hawkey, Nancy J. (1970) *Instructor in English*
B.A., M.A., Arizona State University
- Hawley, John B. (1957) *Instructor in Engineering*
B.S., E.M.E.T., Colorado School of Mines

- Haygood, Robert C. (1970) *Professor of Psychology*
B.S., University of Illinois; M.S., Ph.D., University of Utah
- Heathcotte, James B. (1969) *Assistant Professor of Finance*
A.B., M.B.A., D.B.A., Indiana University
- Hedrick, John K. (1970) *Assistant Professor of Engineering*
B.S.E.M., University of Michigan; M.S., Ph.D., Stanford University
- Heffernan, Charles W. (1967) *Associate Professor of Music*
B.Mus., M.Mus., Ph.D., University of Michigan
- Heier, William D. (1966) *Associate Professor of Management*
B.S., University of Maryland; M.A., George Washington University;
Ph.D., American University
- Heimann, Robert A. (1952) *Professor of Education;*
Director of Counselor Training Center
B.S., Wisconsin State College; M.S., Ph.D., University of Wisconsin
- Helmkamp, John G. (1968) *Associate Professor of Accounting;*
Chairman, Department of Accounting
B.S., Purdue University; M.B.A., D.B.A., Indiana University
- Helmstadter, G. C. (1959) *Professor of Education*
Director, University Testing Service
B.S., M.S., Iowa State University; Ph.D., University of Minnesota
- Hendrickson, Lester E. (1968) *Assistant Professor of Engineering*
B.S., M.S., Michigan Technological University; Ph.D., University of Illinois
- Henkel, Ray (1966) *Assistant Professor of Geography*
B.S., Arizona State University; M.S., University of Wisconsin
- Hennefer, Kenneth (1970) *Instructor in Social Work*
B.S., M.S.W., University of Utah
- Hensel, James S. (1970) *Assistant Professor of Marketing*
B.A., Ohio Northern University; M.B.A., Miami University;
Ph.D., Ohio State University
- Henze, Lura F. (1966) *Assistant Professor of Sociology*
B.S., M.A., Arizona State University
- Herman, George R. (1956) *Associate Professor of English*
B.S., M.A., University of Kansas
- Herman, Richard (1970) *Associate Professor of Social Work*
B.A., M.S.S.W., University of Wisconsin
- Hershauer, James C. (1969) *Assistant Professor of Quantitative Systems*
B.S., Purdue University; M.B.A., D.B.A., Indiana University
- Hershberger, Robert G. (1969) *Associate Professor of Architecture*
A.B., Stanford University; B.Arch., University of Utah;
M.Arch., Ph.D., University of Pennsylvania
- Hestenes, David (1966) *Associate Professor of Physics*
B.A., Pacific Lutheran College; M.A., Ph.D., University of California, Los Angeles
- Hetherington, John J. (1970) *Assistant Professor of Speech*
B.A., University of Missouri; M.A., Ph.D., University of Kansas and Theatre
- Higbee, William W. (1968) *Assistant Professor of Technology*
B.S., Texas A&M University; M.B.A., U.S.A.F. Institute of Technology
- Higgins, Norman C. (1968) *Associate Professor of Education*
B.S., Central Missouri State College; M.S., Ph.D., Syracuse University
- Higgins, Walter T. (1967) *Associate Professor of Engineering*
B.E.E., Manhattan College; M.S., Ph.D., University of Arizona
- Hilkert, E. J. (1933) *Professor Emeritus of Accounting;*
Dean Emeritus, College of Business Administration
B.S. in B.A., M.A., University of Southern California;
LL.B., University of Notre Dame; C.P.A., Arizona and California
- Hill, Bernard (1966) *Associate Professor of Social Work*
B.S.S., College of the City of New York; M.S.W., Tutane University
- Hill, Louis A., Jr. (1958) *Professor of Engineering*
B.A., B.S.C.E., M.S.C.E., Oklahoma State University;
Ph.D., Case Institute of Technology
- Hines, Harold C. (1952) *Associate Professor of Music*
B.S., M.S., University of Illinois
- Hink, Heinz R. (1958) *Professor of Political Science*
LL.B., University of Berlin (Germany); M.A., Ph.D., University of Washington
- Hinshaw, Donald A. (1967) *Associate Professor of Architecture*
B.Arch., University of Notre Dame
- Hogan, M. Janice (1966) *Assistant Professor of Home Economics*
B.S., Colorado State University; M.A., Michigan State University
- Hogan, Timothy D. (1970) *Assistant Professor of Economics*
A.B., University of California, Berkeley; M.A., University of California, Davis;
Ph.D., Virginia Polytechnic Institute
- Holloway, John R. (1969) *Assistant Professor of Chemistry*
B.S., University of Oregon; Ph.D., Pennsylvania State University
- Holmes, Marguerite J. (1969) *Associate Professor of Nursing*
B.S.N., M.S.N., University of Washington
- Holsinger, Jeannie L. (1968) *Instructor in English*
B.A., M.A., Arizona State University
- Hoover, Helene M. (1957) *Associate Professor of Home Economics*
B.S., M.S., Louisiana State University; Ed.D., Oklahoma State University
- Hoover, Kenneth H. (1956) *Professor of Education*
B.S., M.A., Louisiana State University; Ed.D., University of Washington
- Hopkins, Ernest J. (1949) *Professor Emeritus of Mass Communications*
B.A., University of Southern California; LL.D., Arizona State University
- Horwitch, Arnold (1970) *Instructor in Humanities*
Ph.B., University of Chicago; M.S., Lowell Institute of Technology;
M.A., Arizona State University
- Hoult, Thomas F. (1964) *Professor of Sociology*
A.B., University of Illinois; M.A., Whittier College;
Ph.D., University of Southern California

- Howells, Edmund G. (1960) *Assistant Professor of Philosophy*
B.A., University of Utah; M.A. (Phil.), University of Michigan;
M.A. (English), Middlebury College
- Hoyt, Charles D., Jr. (1962) *Professor of Engineering*
B.S., M.S., Ph.D., Purdue University
- Hubbard, Paul G. (1950) *Professor of History;*
Chairman, Department of History
A.B., Wabash College; M.A., Ph.D., University of Illinois
- Hudson, John W. (1964) *Professor of Sociology*
B.S., M.A., Ph.D., Ohio State University
- Huhnke, Frances S. (1964) *Assistant Professor of Nursing*
R.N., Philadelphia General Hospital School of Nursing;
B.S., University of Arizona; M.S., University of Colorado
- Huizingh, William (1959) *Professor of Accounting;*
Associate Dean, College of Business Administration
B.S.B.A., M.B.A., University of Denver; Ph.D., University of Michigan;
C.P.A., Arizona and Colorado
- Humphrey, Ted B. (1966) *Assistant Professor of Philosophy*
A.B., M.A., University of California, Riverside;
Ph.D., University of California, San Diego
- Hunnicutt, Harold B. (1962) *Professor of Education;*
Associate Dean, Graduate College
B.S., Ed.M., Ed.D., University of Oklahoma
- Hunter, Betty A. (1966) *Assistant Professor of Home Economics*
B.S., M.Ed., University of North Carolina at Greensboro
- Huntington, Virginia R. (1962) *Associate Professor of Accounting*
B.A., M.B.A., University of Kansas; Ph.D., University of Texas;
C.P.A., Missouri and Arizona
- Huston, Gerald D. (1962) *Assistant Professor of Quantitative Systems*
B.S.C., M.A., Ph.D., State University of Iowa
- Hutchison, Michael P. (1969) *Instructor in English*
B.A., M.A., University of Missouri
- Imdieke, LeRoy F. (1968) *Associate Professor of Accounting*
B.S., Valley City State College; M.A., University of North Dakota;
Ph.D., University of Illinois; C.P.A., Illinois
- Impson, Wells F. (1960) *Assistant Professor of Physics*
B.S., United States Coast Guard Academy; M.S., Arizona State University
- Inskip, Gordon C. (1968) *Associate Professor of Management*
B.Ch.E., Ohio State University; Ph.D., Columbia University
- Isaak, Donald (1962) *Associate Professor of Music*
B.F.A., University of South Dakota; M.M., D.M., Northwestern University
- Jacks, Mary L. (1955) *Associate Professor of Office Administration*
and Business Education
B.A., M.A., Arizona State University; C.P.S., Arizona
- Jackson, Marvin R., Jr. (1962) *Associate Professor of Economics*
B.S., M.A., University of Colorado; Ph.D., University of California, Berkeley
- Jacob, Richard J. (1963) *Associate Professor of Physics*
B.S., Ph.D., University of Utah
- Jacobson, Arthur (1956) *Professor of Art*
B.S., M.S., University of Wisconsin
- Jacobowitz, Ronald (1970) *Professor of Mathematics*
M.A., City College of New York; M.S., University of Chicago;
Ph.D., Princeton University
- Jakob, John H. (1960) *Associate Professor of Architecture*
B.Arch., Ohio State University; M.S. in Arch., Columbia University
- Jankowski, Daniel F. (1964) *Associate Professor of Engineering*
B.S., M.S., Ph.D., University of Michigan
- Janssen, James G. (1968) *Assistant Professor of English*
B.A., M.A., Marquette University; Ph.D., University of Wisconsin
- Jelinek, James J. (1953) *Professor of Education*
B.S., University of Illinois; M.A., Northwestern University;
Ed.D., Indiana University
- Jelsma, Lawrence F. (1967) *Associate Professor of Engineering*
B.S., Oklahoma State University; M.S., Northwestern University;
Ph.D., University of Delaware
- Jo, Yung-Hwan (1966) *Associate Professor of Political Science*
B.A., Lincoln Memorial University; M.A., University of Tennessee;
Ph.D., American University
- Johnson, Alan P. (1967) *Assistant Professor of English*
B.A., Amherst College; M.A., University of Michigan;
Ph.D., University of Minnesota
- Johnson, David N. (1969) *Professor of Music*
B.M., Trinity University; M.M., Ph.D., Syracuse University
- Johnson, Edwin (1969) *Instructor in English*
B.A., M.A., University of Colorado
- Johnson, Patricia A. (1969) *Assistant Professor of Health, Physical*
Education and Recreation
B.A., M.A., Morehead State University
- Johnson, Rosemary (1959) *Professor of Nursing*
R.N., Milwaukee County General Hospital; B.S., M.P.H., University of Minnesota
- Johnson, Roy M. (1952-53; 1955) *Professor of Microbiology*
A.B., M.S., University of Chicago; Ph.D., University of New Mexico
- Jones, Austin (1968) *Professor of Psychology;*
Chairman, Department of Psychology;
Director, Clinical Psychology Training Program
A.B., University of Illinois; M.S., Purdue University;
Ph.D., University of Rochester
- Jones, Daisy (1963) *Associate Professor of Education*
B.S., M.S., Ed.D., Indiana State University

- Judd, B. Ira (1937) *Professor of Agronomy*
B.S., M.S., Utah State University; Ph.D., University of Nebraska
- Justus, Jerry T. (1968) *Associate Professor of Zoology*
A.B., Franklin College; M.A., Ph.D., Indiana University
- Juvet, Richard S., Jr. (1970) *Professor of Chemistry*
B.S., Ph.D., University of California, Los Angeles
- Kagy, Virginia L. (1947) *Professor of Home Economics;*
Director, Nursery School
B.A., Drake University; M.S., Iowa State University;
Ph.D., Johns Hopkins University
- Kahn, B. Winston (1966) *Assistant Professor of History*
B.A., National Taiwan University (China); M.A., University of Minnesota;
Ph.D., University of Pennsylvania
- Kajikawa, William M. (1937) *Associate Professor of Health,*
Physical Education and Recreation; Freshman Football Coach
B.A. in Ed., M.A. in Ed., Arizona State University
- Kaminsky, Elijah Ben-Zion (1962) *Associate Professor of*
Political Science
A.B., A.M., Ph.D., Harvard University
- Kanneman, Thomas A. (1970) *Associate Professor of Technology*
B.S.E.E., University of Wisconsin; M.S.E.E., University of New Mexico;
Ph.D. E.E., University of Wisconsin
- Karnes, Thomas L. (1968) *Professor of History*
A.B., Colorado University; A.M., Ph.D., Stanford University
- Kauffman, Albert (1969) *Assistant Professor of Education;*
Associate Director, I. D. Payne Laboratory
B.S., Geneva College; M.Ed., Ph.D., Texas A&M University
- Kaufman, Irving (1965) *Professor of Engineering*
B.E., Vanderbilt University; M.S., Ph.D., University of Illinois
- Kaufmann, William B. (1968) *Assistant Professor of Physics*
A.B., M.A., Ph.D., University of California, Berkeley
- Kazmier, Leonard J. (1965) *Professor of Quantitative Systems;*
Chairman, Department of Quantitative Systems
A.B., M.A., Wayne State University; Ph.D., Ohio State University
- Kearney, James R., III (1968) *Associate Professor of History*
B.A., Pomona College; M.A., Washington University;
Ph.D., University of Wisconsin
- Keating, Patricia B. (1948) *Associate Professor of Music*
B.M., University of Illinois; M.M., Northwestern University
- Kehl, Delmar G. (1965) *Associate Professor of English*
B.A., Bob Jones University; M.S., University of Wisconsin;
Ph.D., University of Southern California
- Keith, Marlow (1946) *Assistant Professor of Industrial*
Technical Education
B.A. in Ed., M.A. in Ed., Arizona State University
- Kelley, Nancy A. (1969) *Assistant Professor of Nursing*
B.S., Nazareth College; M.S., University of Rochester
- Kelly, John B. (1963) *Professor of Mathematics*
B.A., Columbia University; Ph.D., Massachusetts Institute of Technology
- Kelly, Richard W. (1965) *Professor of Engineering*
B.S.E.E., M.S., Ph.D., State University of Iowa
- Kelso, Louise F. (1965) *Assistant Professor of Home Economics*
B.S., Iowa State University; M.A., San Diego State University
- Kennedy, Thomas D. (1967) *Assistant Professor of Psychology*
B.A., Tulane University;
M.A., Ph.D., Louisiana State University and A. & M. College
- Kentera, Lawrence K. (1966) ... *Instructor in Health, Physical Education*
and Recreation; Assistant Football Coach
B.A., M.A., Arizona State University
- Kerr, Nancy J. (1968) *Associate Professor of Education*
B.S., University of Illinois; M.A., Ph.D., University of Houston
- Kevane, Clement J. (1956) *Professor of Physics*
B.S., Ph.D., Iowa State University
- Kiesow, Milton A. (1957) *Associate Professor of Education*
B.S., University of Wisconsin; M.A., Ph.D., University of Nebraska
- Kigin, Denis J. (1958-65; 1967) ... *Professor of Industrial Technology;*
Dean, University Extension; Director, Summer Sessions
B.S., Mankato State College; M.S., Stout State University;
Ed.D., University of Missouri
- Killeen, Peter R. (1968) *Assistant Professor of Psychology*
B.S., Michigan State University; Ph.D., Harvard University
- Kimler, Stephen J. (1967) *Associate Professor of Education;*
Counselor, University Counseling Service
B.Ed., Milwaukee State Teachers College; M.Ed., Marquette University;
Ed.D., Arizona State University
- Kingsbury, Warren T. (1964) *Associate Professor of Education*
A.B., Central College, Fayette, Missouri; A.M., University of Missouri;
Ed.D., New York University
- Kingston, Jerry L. (1969) *Assistant Professor of Economics;*
Research Associate, Bureau of Business and Economic Research
B.A., Wayne State College; M.S., Colorado State University;
Ph.D., Pennsylvania State University
- Klann, Margaret (1945) *Associate Professor of Health,*
Physical Education and Recreation
B.S., University of Illinois; M.A. in Ed., Colorado State College of Education
- Kleinfeld, Gerald R. (1962) *Associate Professor of History*
B.A., New York University; M.A., University of Michigan;
Ph.D., New York University

- Klingensmith, John E. (1969) *Assistant Professor of Education*
B.S., Notre Dame University; M.A., St. John's University;
Ph.D., Iowa State University
- Klock, John W. (1960) *Professor of Engineering*
B.E., University of Southern California;
M.S., Ph.D., University of California, Berkeley
- Knapp, Robert E., Col. (1969) *Professor of Military Science;*
Chairman, Department of Military Science
B.S., U.S. Military Academy; M.P.A., Princeton University
- Knaupp, Jonathan E. (1970) *Assistant Professor of Education*
B.S., Oregon State University; M.A., Ph.D. University of Illinois
- Knowlton, John F. (1964) *Associate Professor of Spanish*
B.A., Lewis and Clark College; M.A., Ph.D., University of Oregon
- Knox, Robert L. (1963) *Professor of Economics*
B.S., M.S., Oklahoma State University; Ph.D., University of North Carolina
- Koslow, Lawrence E. (1969) *Assistant Professor of Political Science*
B.A., California State College, Los Angeles;
M.A., Ph.D., University of California, Riverside
- Krenkel, John H. (1947) *Professor of History*
B.S. in Ed., University of Illinois; M.A., Claremont Graduate School;
Ph.D., University of Illinois
- Krueger, H. Calvert (1957) *Associate Professor of Accounting*
B.S. in B.A., University of Wichita; M.A., University of North Dakota;
C.P.A., Arizona, Kansas, Missouri and North Dakota
- Krylova, Iryna (1966) *Instructor in Russian*
M.A., S.A.H.M.C., Moscow
- Kuester, James L. (1969) . . . *Associate Professor of Chemical Engineering*
B.S., University of Texas, Austin; M.E., Ph.D., Texas A&M University
- Kunkel, John H. (1959) *Professor of Sociology*
B.A., Pomona College; A.M., Ph.D., University of Michigan
- Kurtz, Lynn C. (1967) *Associate Professor of Mathematics*
B.S., South Dakota School of Mines and Technology;
M.S., Ph.D., University of Utah
- Kush, Frank (1957) *Assistant Professor of Health, Physical*
Education and Recreation; Head Football Coach
B.A., Michigan State University; M.S., Arizona State University
- Kyrala, Ali (1960-62; 1964) *Professor of Physics*
B.S., Massachusetts Institute of Technology; M.S., Stanford University;
S.M., Harvard University; D.S., Technische Hochschule Wien (Austria)
- Ladman, Jerry R. (1967) *Assistant Professor of Economics*
B.S., Ph.D., Iowa State University
- Laetz, Hans G. (1964) *Assistant Professor of German*
A.B., University of California, Berkeley; A.M., Ph.D., Stanford University
- LaFrance, Arthur B. (1969) *Professor of Law*
B.A., Dartmouth College; LL.B., Yale Law School
- Lake, Robert L. (1958) *Instructor in Mathematics*
B.S., South Dakota School of Mines and Technology;
M.A., Arizona State University
- Lamberts, Jacob J. (1960) *Professor of English*
B.A., Calvin College; M.A., Ph.D., University of Michigan
- Lamm, Robert C. (1959) *Professor of Humanities and Music;*
Director, Center for the Humanities
B.M., University of Louisville; M.M., University of Arizona;
Ph.D., Indiana University
- Lance, Robert E. (1960) . . . *Assistant Professor of Mass Communications*
B.S., Kent University; M.S., Northwestern University
- Landeira, Ricardo L. (1962) *Associate Professor of Spanish*
Bachiller Universitario, University of Santiago (Spain);
Maestro Nacional, Escuela Normal of Santiago (Spain);
Ph.D., University of Colorado
- Landers, E. James (1960) *Professor of Zoology*
A.B., M.S., University of Wyoming; Ph.D., New York University
- Larimer, John W. (1969) *Assistant Professor of Geology*
B.A., M.S., Ph.D., Lehigh University
- Larson, Arlyn J. (1964) *Associate Professor of Economics*
Ph.B., M.A., University of North Dakota; Ph.D., University of Illinois
- Lavik, Rudolph H. (1933) *Professor Emeritus of Health, Physical*
Education and Recreation
B.A., Concordia College; B.P.E., Springfield College;
M.A., University of Southern California
- Lawler, Eugene D. (1967) *Assistant Professor of*
Engineering Communications
B.S., Northern State College (South Dakota); M.A., Arizona State University
- Lawyer, Gerald J. (1969) *Assistant Professor of Spanish*
A.B., B.S., A.M., Indiana University
- Leathers, Chester R. (1957) *Associate Professor of Botany*
B.S., Eastern Illinois University; M.S., Ph.D., University of Michigan
- Lee, Idelle B. (1962) *Assistant Professor of Education*
B.A., University of Wisconsin; M.A., Arizona State University
- Lee, Stephen E. (1969) *Professor of Law*
B.A., LL.B., University of Minnesota
- Lendle, Janet M. (1967) *Assistant Professor of Nursing*
B.S., St. Scholastica College; M.S., University of Minnesota
- Leonard, Philip A. (1968) *Assistant Professor of Mathematics*
A.B., Boston College; M.A., Ph.D., Pennsylvania State University
- Leshowitz, Barry H. (1970) *Assistant Professor of Psychology*
B.S., M.A., Brooklyn College; Ph.D., City University of New York

- Lessard, Elizabeth C. (1969) *Assistant Professor of Health, Physical Education and Recreation*
B.S. Ed., Georgia College; M.A., Texas Woman's University
- Levan, Frederick D. (1965) *Associate Professor of Education*
B.S., M.Ed., Pennsylvania State University; Ed.D., Oklahoma State University
- Levine, Gustav (1967) *Associate Professor of Psychology*
B.A., M.A., College of the City of New York; Ph.D., Columbia University
- Levy, Leo B. (1959) *Professor of English;*
Director, Graduate English Studies
A.B., M.A., Ph.D., University of California, Berkeley
- Lewis, Maurice S. (1954) *Professor of Education*
B.S. in Ed., M.S. in Ed., Drake University;
Ed.D., Colorado State College of Education
- Lewis, William E. (1965) *Associate Professor of Engineering*
B.E.S., Johns Hopkins University; M.S., Ph.D., Northwestern University
- Leyba, Raul L. (1970) *Associate Professor of Sociology*
B.A. (Eng.), New Mexico Western University; M.S.W., University of Denver
- Lightfoot, Marjorie J. (1964) *Associate Professor of English*
B.A., Brown University; M.A., Ph.D., Northwestern University
- Lightfoot, Nancy L. (1970) *Instructor in English*
B.A., M.A., Arizona State University
- Lill, David J. (1971) *Assistant Professor of Marketing*
B.B.A., Ohio University; M.B.A., Bowling Green State University
- Lin, Sheng H. (1965) *Associate Professor of Chemistry*
B.S., M.S., National Taiwan University (China); Ph.D., University of Utah
- Lindell, James (1967; 1970) *Instructor in English*
B.A., M.A., Arizona State University
- Linderman, Earl W. (1966) *Professor of Art;*
Chairman, Department of Art
B.S., New York State College for Teachers at Buffalo;
M.Ed., D.Ed., Pennsylvania State University
- Lindstrom, Frederick B. (1953) *Professor of Sociology*
A.B., M.A., Ph.D., University of Chicago
- Liskovec, Richard F. (1958) *Assistant Professor of Mathematics*
B.S., M.A., Kent State University
- Little, Ronald L. (1970) *Assistant Professor of Sociology*
B.A., University of Utah; M.A., University of Oregon
- Littlewood, Mary L. (1965) *Assistant Professor of Health,*
Physical Education and Recreation
B.S. in Ed., Miami University; M.S., University of Colorado
- Littrell, Joseph J. (1958) *Professor of Industrial Technical Education*
A.B., Peru State Teachers College; M.A., University of Minnesota;
Ed.D., University of Missouri
- Liu, Chui H. (1965) *Professor of Chemistry*
B.A., Ph.D., University of Illinois
- Livermore, Paul E. (1958) *Assistant Professor of Mathematics*
B.S., M.A., Arizona State University
- Lofgreen, Harold A., Jr. (1969) *Assistant Professor of Economics*
B.A., Simpson College; M.A., State University of Iowa
- Logan, Earl, Jr. (1963) *Professor of Engineering*
B.S., M.S., Texas A&M University; Ph.D., Purdue University
- Loge, Betty J. (1962) *Associate Professor of Nursing*
B.S., M.S., University of Minnesota
- Loing, Corrine V. (1970) *Assistant Professor of Nursing*
R.N., Deaconess Hospital; B.S., California State College, Los Angeles;
M.N., University of California, Los Angeles
- Lombardi, Eugene P. (1957) *Professor of Music*
B.Mus.Ed., Westminster College; M.A., Columbia University
- LoPresti, Ronald (1964) *Associate Professor of Music*
B.M., M.M., Eastman School of Music
- Lounsbury, John F. (1969) *Professor of Geography;*
Chairman, Department of Geography
B.S., M.S., University of Illinois; Ph.D., Northwestern University
- Lowe, John W. (1956) *Associate Professor of Economics*
B.S., Arizona State University; M.S., University of Wisconsin;
Ph.D., University of Florida
- Lowe, Robert W. (1966) *Professor of Romance Languages*
M.A., Columbia University; Doctorat, University of Paris
- Lowenstein, Milton D. (1959) *Associate Professor Emeritus*
of Architecture
B.A., M.A., Columbia University
- Lu, Pao (1964) *Associate Professor of Physics*
B.S., National Taiwan University (China);
M.S., National Tsing Hua University (China); Ph.D., Iowa State University
- Luchsinger, Wayne W. (1966) *Professor of Chemistry*
B.S., M.S., Ph.D., University of Minnesota
- Luckingham, Bradford F. (1971) *Assistant Professor of History*
B.S., Northern Arizona University; M.A., University of Missouri;
Ph.D., University of California, Davis
- Luenow, Paul F., Jr. (1958) *Associate Professor of Spanish*
B.A., M.A., University of Washington; Ph.D., University of New Mexico
- Lundberg, Horace W. (1962) *Professor of Social Work;*
Dean, Graduate School of Social Service Administration
B.S., Utah State University; M.S.W., University of California, Berkeley;
Ph.D., University of Minnesota
- Lundgren, Harry R. (1962) *Associate Professor of Engineering*
B.S.C.E., Purdue University; M.S., Arizona State University;
Ph.D., Oklahoma State University

- Lundin, Robert F. (1962) *Associate Professor of Geology*
B.A., Augustana College; M.S., Ph.D., University of Illinois
- Lyle, Mary G. (1959) *Assistant Professor Emeritus of English*
B.A., State University of Iowa; M.A., University of South Dakota
- Lyon, Robert B. (1938) *Professor of Mathematics*
B.S., B.M., University of Illinois; M.S., University of Idaho
- McCarter, Joan H. (1961) *Assistant Professor of Mathematics*
B.S., M.A., University of Arizona
- McClellan, Muriel H. (1968) *Assistant Professor of Nursing*
B.S., Arizona State University; M.N., University of California, Los Angeles
- McCready, Richard R. (1960) *Professor of Quantitative Systems*
B.S., Valley City State Teachers College; M.A., Ed.D., Colorado State College
- McDonald, Joe (1969) *Instructor in Health, Physical Education
and Recreation; Student Counselor and Assistant Football Coach*
B.S., Arizona State University
- McDonald, John N. (1969) *Assistant Professor of Mathematics*
A.B., Kings College; M.S., Ph.D., Rutgers, The State University
- McEwen, Douglas R. (1969) *Associate Professor of Music;
Director of Choirs*
B.S., Bowling Green State University; M.M., Indiana University;
Ed.D., Colorado State College
- McGaw, Dickinson L. (1968) *Assistant Professor of Political Science*
A.B., A.M., Ph.D., Indiana University
- McGrath, G. D. (1950) *Professor of Education*
A.B., Findlay College; M.A., University of Michigan;
Ph.D., University of Colorado
- McGreevy, C. Patrick (1966) *Associate Professor of Education*
B.A., Western Washington State College; M.A., Washington State University;
Ph.D., Arizona State University
- McIntire, E. Bernell (1959) *Associate Professor of German*
A.B., M.A., Brigham Young University; Ph.D., University of Michigan
- McKenzie, Patrick B. (1970) *Assistant Professor of Accounting*
B.S., M.S., Kansas State University; Ph.D., Michigan State University;
C.P.A., Kansas
- McLeod, Dorothy L. (1957-61, 1962-64, 1970) *Professor of Nursing*
R.N., St. Joseph's Hospital; B.S.N., St. Louis University;
M.S., Columbia University Teachers College; Ph.D., University of Washington
- McNall, Scott G. (1970) *Associate Professor of Sociology*
B.A., Portland State University; Ph.D., University of Oregon
- McTaggart, W. Donald (1971) *Associate Professor of Geography*
B.A., M.A., University of St. Andrews, Scotland;
Ph.D., Australian National University
- McWhirter, J. Jeffries (1970) *Assistant Professor of Education*
B.A., St. Martin's College; M.Ed., Oregon State University;
M.Ed., Ph.D., University of Oregon
- Mackey, Lola A. (1970) *Assistant Professor of Spanish*
B.A., University of California, Berkeley; M.A., University of New Mexico
- Madore, C. Elizabeth (1968) *Associate Professor of Nursing*
R.N., Peter Bent Brigham Hospital School of Nursing; B.S., Boston University;
M.A., Columbia University
- Maes, Wayne R. (1966) *Associate Professor of Education*
Th.B., Owosso Bible College; M.A., Ph.D., Michigan State University
- Malone, Charles F. (1966) *Associate Professor of Education*
B.S., Kansas State Teachers College; M.Ed., Ed.D., University of Kansas
- Mamalis, A. David (1969) *Assistant Professor of Education*
B.A., Southern California College; M.A., University of Denver
- Manheim, Henry L. (1958) *Professor of Sociology*
A.B., University of California, Los Angeles;
M.A., Ph.D., University of Southern California
- Mann, William G. (1961) *Instructor in Health, Physical
Education and Recreation; Freshman Basketball Coach;
Varsity Golf Coach*
B.S. in Ed., M.Ed., University of Arizona
- Manning, Duane (1951) *Professor of Education*
B.A., M.A., Ball State Teachers College; Ed.D., Indiana University
- Martin, John F., Jr. (1966) *Assistant Professor of Anthropology*
B.A., Beloit College; M.A., Ph.D., University of Chicago
- Martínez, Quino E. (1957) *Professor of Spanish*
B.S., New Mexico Western College; M.A., George Peabody College;
Ph.D., University of North Carolina
- Marzke, Robert (1969) *Assistant Professor of Physics*
A.B., Princeton University; Ph.D., Columbia University
- Mason, Bruce B. (1960) *Professor of Political Science*
B.S., North Texas State College; M.A., Texas Christian University;
Ph.D., University of Texas, Austin
- Matheson, Alan A. (1968) *Professor of Law; Associate Dean,
College of Law*
B.A., M.S., J.D., University of Utah
- Matte, Paul J. (1970) *Instructor in English*
B.A., University of the South; M.A., Arizona State University
- Matthias, Judson S. (1967) *Associate Professor of Engineering*
B.S., U.S. Military Academy; M.S., Oregon State University;
Ph.D., Purdue University
- Maxwell, Lawrence E. (1968) *Assistant Professor of Geography*
A.B., Washington University; M.S., Purdue University;
M.A., University of California, Los Angeles
- Mayer, Albert J. (1968) *Professor of Sociology*
A.B., A.M., Ph.D., University of Chicago
- Mazen, S. David (1970) *Assistant Professor of Education*
B.A., Whitworth College; M.Ed., Eastern Washington State College;
Ed.D., Washington State University

- Mech, Edmund V. (1964)** *Professor of Social Work*
A.B., Florida Southern College; M.S.S., Bryn Mawr College;
M.S. in Ed., Ph.D., Indiana University
- Meister, Arnold G. (1957)** *Professor of Physics*
B.S., Central YMCA College; Ph.D., Illinois Institute of Technology
- Mendleson, Jack L. (1967)** *Associate Professor of Management*
B.B.A., Butler University; M.B.A., Indiana University;
D.B.A., Michigan State University
- Menke, Robert F. (1947)** *Professor of Education;*
Director, Career Services
B.S., Oshkosh State College; M.A. in Ed., Ph.D., Northwestern University
- Merkel, Richard L. (1961-63; 1969)** *Assistant Professor of*
Business Administration
B.B.A., J.D., University of Wisconsin
- Mertens, Marjorie K. (1969)** *Assistant Professor of Education*
B.A., University of Pittsburgh; M.S., Columbia University;
M.A., Ed.D., University of Arizona
- Metos, Thomas H. (1965)** *Associate Professor of Education*
B.S., M.S., Ph.D., University of Utah
- Metzger, Darryl E. (1963)** *Professor of Engineering*
B.S. in M.E., M.S. in M.E., Ph.D., Stanford University
- Metzler, James M., SSG (1970)** ... *Assistant Professor of Military Science*
- Meyer, Daniel J. (1970)** *Assistant Professor of Humanities*
B.A., M.A., Ph.D., Arizona State University
- Meyerson, Lee (1962)** *Professor of Psychology*
A.B., Lafayette College; A.M., University of California, Los Angeles;
Ph.D., Stanford University
- Michels, LeMoyné F. (1963)** *Associate Professor of Construction*
B.S., United States Military Academy
- Miller, Glenn A. (1969)** *Associate Professor of Psychology*
B.A., M.A., University of Kentucky; Ph.D., Southern Illinois University
- Miller, Paul T. (1947)** *Professor of Geology*
B.A., Simpson College; M.S., Ph.D., State University of Iowa
- Miller, Robert W. (1969)** *Assistant Professor of Music;*
Assistant Director of Bands
B.A., M.A., Arizona State University
- Miller, Victor J. (1958)** *Professor of Horticulture*
B.S., M.S., Ph.D., University of Illinois
- Miller, William E. (1966)** *Assistant Professor of Education;*
Counselor, University Counseling Service
B.M.E., Ed.D., University of Kansas
- Milner, Joe W. (1967)** ... *Associate Professor of Mass Communications;*
Chairman, Department of Mass Communications
B.S., East Texas State University; M.A., University of Oklahoma;
Ed.D., University of Wyoming
- Minckley, Wendell L. (1963)** *Associate Professor of Zoology*
B.S., Kansas State University; M.A., University of Kansas;
Ph.D., University of Louisville
- Mitchell, Frederic F. (1961)** *Professor of Education*
B.A., M.A., University of Arizona; Ph.D., Columbia University
- Mize, Joe H. (1969)** *Professor of Industrial Engineering*
B.S.I.E., Texas Technological College; M.S.I.E., Ph.D., Purdue University
- Moeller, Therald (1969)** *Professor of Chemistry;*
Chairman, Department of Chemistry
B.S., Oregon State College; Ph.D., University of Wisconsin
- Moerbe, Ronald H., Major (1968)** *Assistant Professor of*
Military Science
B.S., Texas Technological College
- Moffit, Inez (1953)** *Assistant Professor of Education*
B.A., Iowa State Teachers College; B.L.S., University of Minnesota;
M.A., University of Denver
- Moffitt, J. Barry (1967)** *Assistant Professor of Architecture*
B.Arch., University of Southern California
- Molinare, Lorna (1970)** *Assistant Professor of Social Work*
B.S., University of Arizona; M.A., Indiana University;
Post-Master's Certificate, Mental Research Institute, Palo Alto
- Monczka, Robert M. (1970)** *Assistant Professor of Management*
B.A., M.B.A., Ph.D., Michigan State University
- Montague, Mary (1969)** *Instructor in English*
B.A., M.A., Arizona State University
- Monty, Dewey E., Jr. (1969)** *University Veterinarian and*
Associate Professor of Animal Science
B.S., D.V.M., Colorado State University; M.S., University of California, Davis
- Moody, E. Grant (1951)** *Professor of Animal Science*
B.S., University of Arizona; M.S., Kansas State University;
Ph.D., Purdue University
- Moor, William C. (1968)** *Assistant Professor of Engineering*
B.S., M.S., Washington University; Ph.D., Northwestern University
- Moore, Bryon C. (1968)** *Associate Professor of Education*
A.B., Monmouth College; M.Ed., Ed.D., University of Arizona
- Moore, Carleton B. (1961)** *Professor of Chemistry and Geology;*
Director, Center for Meteorite Studies
B.S., Alfred University; Ph.D., California Institute of Technology
- Moore, Harold E. (1966)** *Professor of Education*
A.B., Indiana State Teachers College; A.M., Ed.D., Indiana University
- Moore, J. Douglas (1969)** *Assistant Professor of Mathematics*
B.S., M.S., Idaho State University; Ph.D., Syracuse University
- Moore, Nadine (1969)** *Assistant Professor of Mathematics*
B.S., Idaho State University; M.A., Ph.D., Syracuse University

- Moran, Dennis V. (1964) *Assistant Professor of English*
A.B., University of Notre Dame; B.A., M.A., Oxford University;
Ph.D., Stanford University
- Morgan, Owen W. (1968) *Professor of Home Economics;*
Director, Center for Family Life Studies
B.A., Grinnell College; M.A., University of Omaha; Ph.D., University of Nebraska
- Morris, Donald H. (1962) *Associate Professor of Anthropology*
B.A., Arizona State University; M.A., Ph.D., University of Arizona
- Morris, John P. (1968) *Professor of Law*
B.S., J.D., Northwestern University
- Morris, Mary Scott (1947) *Assistant Professor of Education*
A.B., Western Kentucky State College; M.A., Northwestern University
- Mortensen, Martin (1932) *Associate Professor Emeritus of*
Science Education
A.B., Brigham Young University; A.M., University of Arizona
- Moulton, Gerald L. (1967) *Associate Professor of Education*
B.A., Hamline University; M.Ed., Ed.D., University of Oregon
- Mowrer, Donald E. (1965) *Associate Professor of Speech*
B.A., M.A., Florida State University; Ph.D., Arizona State University
- Mullen, Thomas P. (1971) *Assistant Professor of Education*
B.A., Whittier College; M.A., University of Minnesota
- Munch, Theodore W. (1959) *Professor of Science Education*
B.S., in Ed., B.S. (Bacteriology), Ohio State University;
M.A. in Ed., Colorado State College; Ed.D., Stanford University
- Munk, Morton E. (1961) *Professor of Chemistry*
B.S., Northwestern University; M.S., University of Miami;
Ph.D., Wayne State University
- Murdock, Gordon R. (1970) *Assistant Professor of Zoology*
A.B., Reed College
- Murphy, Elsie L. (1968) *Assistant Professor of Nursing*
R.N., Mt. Carmel Hospital School of Nursing;
B.S., Kansas State College of Pittsburg; M.S., Saint Louis University
- Murphy, Nina L. (1924) *Professor Emeritus of Health,*
Physical Education and Recreation
B.S., University of Arizona; M.A., University of Southern California
- Murray, Roger N. (1968) *Associate Professor of English*
B.A., B.S., Moorhead State Teachers College; M.A., Stanford University;
Ph.D., State University of Iowa
- Myers, Louis M. (1937) *Professor of English*
B.A., St. Stephen's College; M.A., Columbia University;
Ph.D., University of California, Berkeley
- Myler, Charles E., Jr. (1968) *Assistant Professor of Real Estate*
B.B.A., Loyola University; M.B.A., Harvard Business School;
Ph.D., University of Florida
- Naczki, Margaret V. (1969) *Assistant Professor of Nursing*
R.N., St. Joseph's Hospital School of Nursing; B.S., Incarnate Word College;
M.S., University of Colorado
- Nagasawa, Richard H. (1969) *Assistant Professor of Sociology*
B.A., University of Hawaii; M.A., Ph.D., University of Washington
- Navrotsky, Alexandra (1969) *Assistant Professor of Chemistry*
B.S., M.S., Ph.D., University of Chicago
- Nebeker, Helen E. (1958) *Assistant Professor of English*
B.A., M.A., Arizona State University
- Neilsen, Michael J. (1969) *Assistant Professor of Industrial Design*
B.P.D., North Carolina State University; M.A., Stanford University
- Nelson, Harold D. (1967) *Associate Professor of Engineering*
B.S., South Dakota School of Mines and Technology;
M.S., Kansas State University; Ph.D., Arizona State University
- Nelson, John C. (1967) *Assistant Professor of Education*
B.S., M.A., Arizona State University; Ph.D., Peabody College
- Nering, Evar D. (1960) *Professor of Mathematics*
A.B., A.M., Indiana University; A.M., Ph.D., Princeton University
- Neuheisel, Richard G. (1963) *Assistant Professor of*
Business Administration
B.B.A., J.D., University of Wisconsin
- Newburn, Harry K. (1963) *Professor of Education*
B.Ed., Western Illinois State University; M.A., Ph.D., State University of Iowa
- Newlin, Charles W. (1961) *Professor of Engineering;*
Chairman, Civil Engineering Faculty
B.S., Rose Polytechnic Institute; M.S., Harvard University;
Ph.D., Northwestern University
- Newman, Karen S. (1968) *Assistant Professor of Education*
B.S., University of Southern California; M.Ed., University of Arizona;
Ed.D., Arizona State University
- Newstrom, John W. (1970) *Assistant Professor of Management*
B.A., M.B.A., Ph.D., University of Minnesota
- Newton, Charles W., LTC (1967) *Assistant Professor*
of Military Science
A.B., University of California, Berkeley
- Ney, James W. (1969) *Associate Professor of English*
B.A., M.A., Wheaton College; Ph.D., University of Michigan
- Nichols, Ann W. (1970) *Assistant Professor of Social Service Work*
A.B., Stanford University; M.S.W., Columbia University
- Nichols, Catherine G. (1952) *Professor of Education*
A.B., M.A., University of Kentucky; Ph.D., Teachers' College, Columbia University
- Nielander, William A. (1958) *Professor Emeritus of Marketing*
B.S., University of Pittsburgh; M.S., Ph.D., Columbia University
- Nielsen, Gordon L. (1968) *Associate Professor of Accounting*
B.S.B.A., University of Tulsa; M.B.A., University of Arizona;
Ph.D., University of Texas, Austin; C.P.A., Arizona, Colorado, Massachusetts

- Nielson, Gregory (1970) *Assistant Professor of Mathematics*
B.S., M.A., Ph.D., University of Utah
- Nielson, Thomas P. (1967) *Assistant Professor of Chinese*
B.A., Brigham Young University; Ph.D., University of Rochester
- Nigham, Bishan Perakash (1964) *Professor of Physics*
B.S., M.S., University of Delhi (India); Ph.D., University of Rochester
- Northey, William T. (1959) *Associate Professor of Microbiology*
B.A., University of Minnesota; M.A., Ph.D., University of Kansas
- Nutt, Merle C. (1956) *Professor Emeritus of Engineering*
B.S., Illinois Institute of Technology; M.A., University of Iowa;
LL.D., Illinois Wesleyan University
- Nutt, Merwyn L., Major (1969) *Assistant Professor of Military Science*
B.S., Texas A&M University
- Nuttall, Dorothy D. (1969) *Assistant Professor of Social Work*
B.A., University of Idaho; M.S.W., University of Utah;
Post-Master's Certificate, Menninger Foundation
- O'Bannon, Charles E. (1964) *Assistant Professor of Engineering*
B.S. in C.E., University of New Mexico; M.S., Harvard University
- O'Beirne, Donald E. (1959) *Professor of Education*
B.E., Whitewater State Teachers College; M.A., Ed.D., Northwestern University
- O'Brien, Carmen A. (1959) *Assistant Professor of Education*
B.A. in Ed., M.A. in Ed., Arizona State University
- O'Connor, Elinor J. (1970) *Assistant Professor of Home Economics*
B.S., College of St. Catherine; M.S., State University of Iowa
- Odenkirk, James E. (1967) *Professor of Health,
Physical Education and Recreation*
B.S., M.A., Ohio State University; Ed.D., Columbia University
- Ohmart, Robert D. (1970) *Assistant Professor of Zoology*
B.S., M.S., New Mexico State University; Ph.D., University of Arizona
- O'Keefe, Michael (1963) *Professor of Chemistry*
B.S., Ph.D., University of Bristol (England)
- Oliver, Robert S. (1963) *Associate Professor of Architecture*
A.B., M.A., University of California, Berkeley
- Olmsted, Cameron B. (1965) *Associate Professor of Education*
B.A. in Ed., M.A. in Ed., Arizona State University; Ed.D., Colorado State College
- Olney, Claude W. (1967) *Assistant Professor of
Business Administration*
B.S., J.D., Marquette University
- O'Malley, Glenn E. (1968) *Professor of English*
B.A., M.A., Western Reserve University; Ph.D. Princeton University
- Osenburg, Frederic C. (1946) *Professor of English*
A.B., M.A., University of Michigan; Ph.D., University of Illinois
- Overman, Glenn D. (1956) *Professor of Business Administration;
Dean, College of Business Administration*
B.S., Central State College; M.S., Oklahoma State University;
D.B.A., Indiana University
- Owen, John E. (1964) *Professor of Sociology*
B.A., Duke University; A.M., Ph.D., University of Southern California
- Owen, Vaughn A., SP5 (1969) *Assistant Professor of Military Science*
- Owens, Bob R. (1967) *Instructor in Health, Physical Education and
Recreation; Assistant Football Coach*
A.B., M.A., Fresno State College
- Packer, Merle (1959) *Associate Professor of Health, Physical
Education and Recreation*
B.A., M.A., Arizona State University
- Page, John B. (1969) *Assistant Professor of Physics*
B.S., Ph.D., University of Utah
- Palais, Joseph C. (1964) *Associate Professor of Engineering*
B.S., University of Arizona; M.S.E., Ph.D., University of Michigan
- Pardini, Louis J. (1967) *Assistant Professor of Industrial
Technical Education*
B.A., A.M., Idaho State University; Ed.D., University of Northern Colorado
- Parker, Howard A. (1966) *Associate Professor of Sociology*
B.A., M.A., Ph.D., University of Washington
- Parker, L. Mayland (1955) *Professor of Agricultural Economics*
B.S., Brigham Young University; M.S., University of Utah;
Ph.D., Cornell University
- Parrish, H. Wayne (1967) *Assistant Professor of Education*
A.B., San Diego State College; M.Ed., Ed.D., University of Oregon
- Parsons, Michael L. (1967) *Assistant Professor of Chemistry*
B.A., M.S., Kansas State College; Ph.D., University of Florida
- Patten, Duncan T. (1965) *Associate Professor of Botany*
B.A., Amherst College; M.S., University of Massachusetts; Ph.D., Duke University
- Patterson, John D. (1967) *Professor of Engineering*
B.S., M.S., Ph.D., University of California, Berkeley
- Patterson, Robert A. (1957) *Associate Professor of Zoology*
B.S., University of Michigan; M.S., Ph.D., Ohio State University
- Paulsen, George E. (1959) *Associate Professor of History*
B.A., Hobart College; M.A., Rutgers, The State University;
Ph.D., Ohio State University
- Peck, George B. (1957) *Assistant Professor of Mathematics*
B.S., Arizona State University; M.S., University of Illinois
- Pedrick, Willard H. (1966) *Professor of Law; Dean, College of Law*
B.A., Parsons College; J.D., Northwestern University
- Peek, George A., Jr. (1964) *Professor of Political Science;
Dean, College of Liberal Arts*
B.A., M.A., Ph.D., University of Virginia

RESIDENT FACULTY

- Pellegrino, Joseph P., Major (1969) *Assistant Professor of Military Science*
B.A., University of Oregon
- Perril, Lester S. (1957) *Professor of Education*
B.A., Ohio Wesleyan University; M.A., Ohio State University;
Ph.D., University of North Carolina
- Perrill, Norman K. (1966) *Associate Professor of Speech and Theatre*
B.S., M.A., Northwestern University; Ph.D., University of Southern California
- Peterman, Gordon G. (1966) *Associate Professor of Construction*
B.S.C.E., Iowa State University
- Peters, Kathleen A. (1967) *Assistant Professor of Home Economics*
B.S., M.S., Kansas State University
- Peterson, John R. (1963) *Associate Professor of Architecture*
B.A., St. Olaf College; B.Arch., University of Minnesota;
M.Arch., Harvard University
- Pettit, George R. (1965) *Professor of Chemistry*
B.S., Washington State University; M.S., Ph.D., Wayne State University
- Péwé, Troy L. (1965) *Professor of Geology;*
Chairman, Department of Geology
A.B., Augustana College; M.S., State University of Iowa;
Ph.D., Stanford University
- Pfuhl, Erdwin H., Jr. (1968) *Associate Professor of Sociology*
A.B., Whitman College; A.M., University of Idaho;
Ph.D., Washington State University
- Philippakis, Andreas S. (1967) *Associate Professor of Quantitative Systems; Supervisor, Business Computer Laboratory*
B.S., Gannon College; M.B.A., Ph.D., University of Wisconsin
- Phillips, William W. (1958) *Associate Professor of History*
Ph.B., M.A., University of North Dakota; Ph.D., University of Missouri
- Pian, Richard H. J. (1959) *Professor of Engineering*
B.S.C.E., Kung Shang University (China); M.S.E., Ph.D., Cornell University
- Pierce, David A., SSG (1969) *Assistant Professor of Military Science*
- Piercey, Dorothy J. (1968) *Assistant Professor of Education*
B.A., College of St. Francis; M.A., Arizona State University;
Ph.D., University of Arizona
- Pike, Kenneth V. (1962) *Associate Professor of Science Education*
B.S., University of Massachusetts; M.A. Long Beach State College;
Ed.D., University of California, Los Angeles
- Pike, Norma J. (1964) *Assistant Professor of Health, Physical Education and Recreation*
B.S., M.S., University of Southern California
- Pinkava, Donald J. (1964) *Associate Professor of Botany*
B.S., M.S., Ph.D., Ohio State University
- Pittman, Anne (1952) *Associate Professor of Health, Physical Education and Recreation*
B.S. in P.Ed., University of Texas, Austin; M.A., New York University
- Plantz, Don V. (1960) *Professor of Economics*
B.S., M.B.A., University of Kansas; Ph.D., Indiana University
- Plummer, Ramona F. (1957) *Assistant Professor of Health, Physical Education and Recreation*
B.S., M.A., University of Alabama
- Podlich, William F. (1949) *Professor of Education*
B.S., Maryland State Teachers College; Ph.D., State University of Iowa
- Polenz, G. Donald (1967) *Associate Professor of Social Work*
B.A., Wartburg College; M.A., State University of Iowa;
D.S.W., University of Southern California
- Powell, Noel G. (1970) *Assistant Professor of Office Administration and Business Education*
B.S.B.A., M.S., University of North Dakota
- Portnoff, Collice H. (1945) *Professor Emeritus of English*
A.B., M.A., University of California, Berkeley;
F.A.A.R., M.A., American Academy in Rome (Italy); Ph.D., Stanford University
- Powers, Doris C. (1960) *Associate Professor of English*
B.A., Wellesley College; M.A., Occidental College;
Ph.D., University of California, Berkeley
- Prater, William C., SGM (1970) *Assistant Professor of Military Science*
- Price, Thornton W. (1961) *Professor of Engineering*
B.S., University of Illinois; M.S., Lehigh University; Ph.D., University of Illinois
- Prust, Zenas A. (1959) *Professor of Industrial Technical Education*
B.S., Stout State University; M.A., University of Minnesota;
Ed.D., University of Northern Colorado
- Putnik, Edwin V. (1962) *Associate Professor of Music*
B.A., Northwestern University; M.M., Eastman School of Music
- Quick, James E. (1969) *Assistant Professor of English*
B.A., University of Michigan; M.A., Eastern Michigan University
- Quirk, Daniel (1959) *Assistant Professor of English*
B.A., B.S., Arizona State University; M.A., New York University
- Radke, Judith J. (1960) *Associate Professor of French*
B.S., M.A., University of Wisconsin; Ph.D., University of Colorado
- Ragan, Donal M. (1967) *Professor of Geology*
B.A., Occidental College; M.S., University of Southern California;
Ph.D., University of Washington
- Ralston, Mack A. (1956) *Professor of Education;*
Chairman, Department of Educational Foundations
B.S., M.S., Indiana State Teachers College; Ed.D., Indiana University
- Randall, Virginia F. (1962) *Assistant Professor of English*
B.A., College of New Rochelle; M.A., Arizona State University;
Ph.D., Occidental College

- Rangeler, Arthur W. (1966) *Instructor in Health,
B.S., M.S., Arizona State University Physical Education and Recreation*
- Rannells, Jessie M. (1939) *Professor of Home Economics
B.S., Iowa State University; M.S., Cornell University;
Ph.D., University of Wisconsin*
- Rapp, James R. (1962) *Associate Professor of Architecture
B.Arch. Engr., University of Detroit; M.S. in Arch., Columbia University*
- Rasmussen, David I. (1963) *Professor of Zoology
B.S., M.S., University of Utah; Ph.D., University of Michigan*
- Rasmussen, Robert D. (1949) *Associate Professor of Animal Science
B.S., Iowa State University; M.S., Washington State University*
- Ratliff, John D. (1954) *Associate Professor of English
B.A. in Ed., Arizona State University; M.A., Claremont Graduate School;
Ph.D., Stanford University*
- Ratterree, Jack L. (1964) *Assistant Professor of Music
B.M., Curtis Institute of Music; M.A., American University*
- Rausch, Jack D. (1965) *Assistant Professor of Music
B.S., M.A., Ohio State University*
- Rave, Wallace J. (1967) *Assistant Professor of Music
B.S., Illinois State University; M.M., University of Illinois*
- Rawls, William S. (1949) *Professor of Physics
B.S., Murray State College; M.S., Tulane University; Ed.D., Iowa State University*
- Ray, William J. (1968) *Associate Professor of Education
B.S., M.S., State University of New York; Ed.D., Wayne State University*
- Reader, Mark (1967) *Associate Professor of Political Science
A.B., A.M., Ph.D., University of Michigan*
- Reddrick, Noel B., Col. (1967) *Professor of Aerospace Studies;
Chairman, Department of Aerospace Studies
B.S., Arizona State University*
- Redwine, Harriet L. (1967) *Instructor in English
B.A., McMurry College; M.A., Arizona State University*
- Reeves, Henry C. (1969) *Professor of Microbiology
B.S., Franklin and Marshall Colleges; M.A., Ph.D., Vanderbilt University*
- Reich, John W. (1965) *Associate Professor of Psychology
B.A., M.S., University of Oklahoma; Ph.D., University of Colorado*
- Reif, William E. (1970) *Associate Professor of Management
B.B.A., M.A., Ph.D., State University of Iowa*
- Rein'l, Robert L. (1961) *Professor of Philosophy
A.B., A.M., Ph.D., Harvard University*
- Reiser, Castle O. (1958) *Professor of Engineering;
Chairman, Chemical Engineering Faculty
B.S., Colorado State University; Petr. Eng., Colorado School of Mines;
Ph.D., University of Wisconsin*
- Reuter, Vincent G. (1961) *Associate Professor of Management
B.S.C., M.A., Ph.D., State University of Iowa*
- Reynolds, Robert S. (1970) *Associate Professor of Music
B.M., Texas Christian University; M.M., University of Texas, Austin*
- Rice, Margaret J. (1968) *Assistant Professor of Speech and Theatre
A.B., A.M., University of Kansas*
- Rice, Ross R. (1950) *Professor of Political Science
M.A., Ph.D., University of Chicago*
- Rice, Roy C. (1946) *Professor of Education
B.S., University of New Mexico; M.S., University of Massachusetts;
Ph.D., University of Texas, Austin*
- Rice, Warren (1958) *Professor of Engineering;
Chairman, Mechanical Engineering Faculty
B.S., M.S., Ph.D., Texas A&M University*
- Richards, Gale L. (1965) *Professor of Speech;
Chairman, Department of Speech and Theatre
B.A., University of Akron; M.A., Ph.D., State University of Iowa*
- Richardson, Deane E. (1970) *Professor of Health, Physical
Education, and Recreation; Chairman, Department
of Health, Physical Education and Recreation
B.S., Bradley University; M.A., Ed.D., Stanford University*
- Richardson, Grant L. (1953) *Professor of Agronomy
B.S., M.S., University of Arizona; Ph.D., Oregon State University*
- Richardson, H. D. (1940) *Professor of Education
Ph.B., Ph.M., University of Wisconsin; Ph.D., Northwestern University;
LL.D., Arizona State University*
- Rickel, Harry P. (1948) *Associate Professor of Music
B.M., M.M., University of Arizona*
- Ricketson, Bertram L., Captain (1970) *Assistant Professor
of Military Science
B.S., North Georgia College*
- Rider, Wendell J. (1953) *Professor Emeritus of Music
B.S., Iowa State Teachers College; M.M., Eastman School of Music;
Ph.D., State University of Iowa*
- Rieke, Eula E. (1968) *Instructor in Nursing
R.N., Children's Hospital School of Nursing; B.S., University of Colorado;
M.S., Boston University*
- Rimm, David C. (1966) *Associate Professor of Psychology
B.S., Florida State University; Ph.D., Stanford University*
- Ripley, Robert E. (1967) *Assistant Professor of Education
B.A., M.A., Ph.D., University of Minnesota*
- Ritterbush, Morris L. (1968) *Assistant Professor of
Speech and Theatre
B.F.A., Kearney State College; M.A., University of California, Davis*

- Robbins, Earl R. (1961) *Associate Professor of Engineering*
B.S., Texas Technological College; M.S., Ph.D., Arizona State University
- Roberts, Leonard G. (1967) *Assistant Professor of Health, Physical Education and Recreation*
A.B., San Jose State College; M.S., University of Illinois
- Roberts, Thomas G. (1970) *Assistant Professor of Education*
B.A., Wake Forest University; M.A., Ph.D., University of North Carolina
- Robinson, Daniel O. (1950) *Professor of Agriculture*
A.B., Brigham Young University; M.S., University of Arizona; Ph.D., Ohio State University
- Robinson, Don R. (1968) *Instructor in Health, Physical Education and Recreation; Gymnastics Coach*
B.A., Colorado State College; M.S., Eastern New Mexico University
- Robinson, Helene M. (1967) *Associate Professor of Music*
B.A., University of Oregon; M.M., Northwestern University
- Robison, Ray C. (1967) *Instructor in Health, Physical Education and Recreation; Trainer*
B.S., Morningside College; M.S., Indiana University
- Rook, Fern H. (1969) *Assistant Professor of Technology*
B.A., University of Colorado; M.A., Arizona State University
- Rose, Jonathan (1968) *Professor of Law*
B.A., University of Pennsylvania; LL.B., University of Minnesota
- Rose, Marion H. (1971) *Professor of Nursing*
B.S., University of Kansas; A.M., University of Chicago
- Rosner, John C. (1969) *Assistant Professor of Engineering*
B.S., Purdue University; M.S., Lehigh University; Ph.D., Purdue University
- Rossi, Patrick J. (1967) *Assistant Professor of Psychology*
B.S., St. Mary's College; M.A., San Fernando Valley College; Ph.D., University of California, Riverside
- Rover, R. Craig (1952) *Professor of Education*
B.A., Upsala College; M.A., St. Lawrence University; Ph.D., Cornell University
- Rowe, Kenneth L. (1962) *Associate Professor of Office Administration and Business Education; Coordinator of Distributive Education*
B.A., M.M., Iowa State Teachers College; Ph.D., Michigan State University
- Rowley, C. Stevenson (1970) *Assistant Professor of Accounting*
B.A., Trinity College; M.B.A., University of Chicago; Ph.D., University of Wisconsin; C.P.A., Illinois
- Roy, Radha R. (1963) *Professor of Physics*
B.Sc., M.Sc., Presidency College, University of Calcutta (India); Ph.D., University of London (England)
- Ruch, William A. (1968) *Assistant Professor of Management*
B.S., M.B.A., D.B.A., Indiana University
- Ruff, Paul F. (1958) *Associate Professor of Engineering*
B.S.C.E., M.S.C.E., Case Institute of Technology
- Ruhala, David M. (1969) *Assistant Professor of Political Science*
A.B., M.P.A., University of Michigan
- Ruiz, Juliette (1970) *Assistant Professor of Social Work*
B.S., University of California, Los Angeles; M.S.W., Arizona State University
- Ruppé, Reynold J. (1960) *Professor of Anthropology; Chairman, Department of Anthropology*
B.A., University of New Mexico; Ph.D., Harvard University
- Russell, Paul E. (1967) *Professor of Engineering*
B.S., New Mexico State University; M.S., Ph.D., University of Wisconsin
- Russell, Stanley J. (1969) *Assistant Professor of Engineering*
B.S., University of Illinois; M.S., Ph.D., University of Wisconsin
- Sacks, Benjamin (1963) *Professor of History*
B.A., University of New Mexico; M.A., McGill University; Ph.D., Stanford University
- Sagramoso, Daniel E., LTC (1969) *Assistant Professor of Military Science*
B.S., Indiana State Teachers College; B.S., Missouri School of Mines
- St. Louis, Robert D., Jr. (1969) *Assistant Professor of Quantitative Systems*
A.B., Rockhurst College; M.S., Purdue University
- Salerno, Nicholas A. (1961) *Professor of English*
B.A. in Ed., M.A., Arizona State University; Ph.D., Stanford University
- Samson, Herman H. (1968) *Assistant Professor of Psychology*
B.A., University of Colorado; M.A., McMaster University (Canada); Ph.D., University of Waterloo (Canada)
- Sanders, Bevie T. (1957) *Associate Professor of Accounting*
B.B.A., North Texas State University; M.S., Texas A&M University; Ph.D., University of Texas; C.P.A., Texas, Arizona
- Sanderson, R. Thomas (1963) *Professor of Chemistry*
B.S., Yale University; Ph.D., University of Chicago
- Sandler, Irwin N. (1970) *Assistant Professor of Psychology*
B.A., Brooklyn College; Ph.D., University of Rochester
- Sandler, Todd M. (1971) *Assistant Professor of Economics*
B.A., M.A., State University of New York
- Sansone, Fred J. (1965) *Associate Professor of Mathematics*
B.S.E., M.S.E., University of Michigan; M.S., Ph.D., Rutgers, The State University
- Satchell, Bernita H. (1961) *Associate Professor of Nursing*
R.N., Ancker Hospital School of Nursing, St. Paul; B.S. in P.H.N., M.P.H., University of Minnesota
- Sater, Vernon E. (1962) *Associate Professor of Engineering*
B.S. in Ch.E., M.S. in Ch.E., Ph.D., Illinois Institute of Technology
- Satterthwaite, Lester L., Jr. (1968) *Associate Professor of Education*
B.S., M.S., Ed.D., Indiana University
- Sattler, Howard (1968) *Associate Professor of Education*
B.S., M.S., Ph.D., Arizona State University

- Savage, Nevin W. (1959)*Professor of Mathematics;*
Chairman, Department of Mathematics
 B.S., M.A., Pennsylvania State University; Ph.D., University of California,
 Los Angeles
- Schabacker, Joseph C. (1963)*Professor of Management*
 B.S., Temple University; M.B.A., Ph.D., University of California, Los Angeles
- Schall, Mary H. (1960-66; 1967)*Assistant Professor of Education*
 B.A., Albion College; M.A., Ed.D., Arizona State University
- Schamadani, James L. (1967)*Professor of Engineering*
 B.S., M.D., Ohio State University
- Schaumburg, Donald (1953)*Professor of Art*
 B.A. in Art Ed., College of Arts and Crafts; M.F.A., Claremont College
- Schiedat, Marilyn L. (1967)*Instructor in English*
 B.A., M.A., Arizona State University
- Schilling, Dorothy C. (1932)*Professor Emeritus of English*
 A.B., M.A., Ph.D., Stanford University
- Schlacter, John L. (1970)*Assistant Professor of Marketing*
 B.B.A., Western Reserve University; M.B.A., Ph.D., Ohio State University
- Schmidt, Alfred H. (1960)*Professor of Marketing*
 B.S., University of Oklahoma; M.B.A., D.B.A., Indiana University
- Schmidt, Jean M. (1966) *Associate Professor of Microbiology*
 B.A., M.S., State University of Iowa; Ph.D., University of California, Berkeley
- Schmidt, Randall B. (1968) *Assistant Professor of Art*
 B.A., Hamline University; M.A., University of New Mexico
- Schoeller, Wilbur C. (1964)*Professor of Engineering*
 B.S. in C.E., M.S. in C.E., Ph.D., University of Texas, Austin
- Schoenwetter, James (1967) *Assistant Professor of Anthropology*
 A.B. (Liberal Arts), A.B. (Anthropology), University of Chicago;
 M.S., University of Arizona; Ph.D., Southern Illinois University
- Schrey, Edward A., PFC (1970) .. *Assistant Professor of Military Science*
- Schrieber, Henry H. (1961) *Assistant Professor of Art*
 B.F.A., University of New Mexico; M.F.A., Cranbrook Academy of Art
- Schroeder, Milton R. (1969) *Associate Professor of Law*
 B.A., Wesleyan University; J.D., University of Chicago
- Schuback, Gertrude B. (1966) *Instructor in German*
 B.A., M.A., Arizona State University
- Schwada, John W. (1971) *Professor of Political Science;*
President of the University
 B.S., Northeast Missouri State College; M.A., University of Missouri;
 Ph.D., University of Texas
- Scott, Walter T. (1961) *Professor of Mathematics*
 B.A., M.A., Ph.D., Rice University
- Scoular, David B. (1952) *Professor of Music;*
Managing Director, Grady Gammage Memorial Auditorium
 B.A., Texas Christian University; B.M., Lawrence College;
 M.A., Columbia University
- Seavy, Viola M. (1970) *Instructor in English*
 B.A., M.A., Arizona State University
- Sebald, Hans (1963) *Associate Professor of Sociology*
 B.A., Manchester College; M.S., Ph.D., Ohio State University
- Sehested, Colene R. (1967) *Assistant Professor of Nursing*
 B.S., University of Arkansas; M.S., University of Maryland
- Seipp, Kenneth F. (1963) *Professor of Music*
 B.S., Hartwick College; M.M., Conservatory of Music, University of Kansas City;
 Mus. Ed.D., Indiana University
- Sekaquaptewa, Eugene (1968) *Instructor in Education*
 B.S., M.A., Arizona State University
- Servin, Manuel P. (1970) *Professor of History*
 B.A., Loyola University (Los Angeles); M.S.W., Boston College;
 M.A., Ph.D., University of Southern California
- Shafer, Robert E. (1966) *Professor of English;*
Director, English Education
 B.S., M.S., University of Wisconsin; Ed.D., Teachers College,
 Columbia University
- Shafer, Susanne M. (1966) *Professor of Education*
 A.B., Smith College; M.A., Syracuse University; Ph.D., University of Michigan
- Shaifer, Edward F., Jr. (1960) *Professor of Construction;*
Director, Division of Construction
 B.S., United States Military Academy; M.B.A., University of Southern California
- Shapiro, David L. (1969) *Associate Professor of Economics*
 M.A., Wayne State University; J.D., Detroit College of Law;
 Ph.D., University of California, Berkeley
- Shell, Leon G. (1967) *Assistant Professor of Education;*
Assistant Dean, Student Relations
 B.A., University of Colorado; A.M., Ed.D., Colorado State College
- Shelton, Robert B. (1970) *Assistant Professor of Economics*
 B.A., Texas Christian University; M.A., University of California, Berkeley;
 Ph.D., Southern Illinois University
- Sheppard, Douglas C. (1971) *Professor of Spanish*
 B.A., Montana State University; M.A., Ph.D., University of Wisconsin
- Sheridan, Michael F. (1967) *Associate Professor of Geology*
 B.A., Amherst College; M.S., Ph.D., Stanford University
- Sherman, Thomas L. (1964) *Associate Professor of Mathematics*
 B.A., University of California, Los Angeles; M.S., Ph.D., University of Utah
- Shipp, Vernon E. (1966) *Instructor in Art*
 B.S., Grand Canyon College; M.A., Arizona State University

- Showalter, Anna M. (1968) *Assistant Professor of Nursing*
R.N., St. Vincent's Hospital; B.S.N., Louisiana State University;
M.S., Tulane School of Public Health
- Silvaroli, Nicholas J. (1963) *Professor of Education;*
Director, Reading Education Center
B.S. in Ed., State University of New York, Fredonia; M.A., University of Buffalo;
Ed.D., Syracuse University
- Simmons, Douglas J. (1963) *Assistant Professor of French*
A.B., Wabash College; M.A.T., Harvard University; Certificat de francais usuel,
degré supérieur; Certificat de prononciation française, La Sorbonne (France)
- Sinkov, Abraham (1964) *Professor of Mathematics*
B.S., College of City of New York; M.A., Columbia University;
Ph.D., George Washington University
- Sirkis, Murray D. (1969) *Professor of Engineering*
B.S., Massachusetts Institute of Technology; M.S., Ph.D., University of Illinois
- Skelton, James W. (1964) *Associate Professor of Education*
B.S., M.A., Ph.D., Ohio State University; LL.B., Rutgers, The State University
- Slattery, Hugh M. (1965) *Assistant Professor of English*
B.S., Northwestern University; M.A., Harvard University
- Smith, Arthur B., Jr. (1967) *Associate Professor of*
Business Administration
B.S., Hardin-Simmons University; M.B.A., Ed.D., University of Houston
- Smith, Charles B. (1964) *Associate Professor of*
Business Administration
B.S., Drake University; M.S., New Mexico Highlands University;
Ed.D., Colorado State College
- Smith, Clyde B. (1952) *Professor of Health,*
Physical Education and Recreation
A.B., Geneva College; M.S. in Ed., Indiana University
- Smith, Lehi T. (1959) *Professor of Mathematics*
B.S., M.A. in Ed., Arizona State University; Ed.D., Stanford University
- Smith, Louise C. (1963) *Professor of Home Economics*
A.B., Texas Christian University; M.A., Columbia University;
Ph.D., Yale University
- Smith, Margo M. (1963) *Assistant Professor of Music*
B.M., Grinnell College; M.A. in Ed., Arizona State University
- Smith, Marion W. (1952) *Assistant Professor of Music*
B.S. in Mus. Ed., Capital University; M.M., American Conservatory of Music
- Smith, Ralph E. (1970) *Assistant Professor of Accounting*
B.B.A., Washburn University; Ph.D., University of Kansas; C.P.A., Kansas
- Smith, Richard L. (1967) *Associate Professor of Engineering*
B.S., Washington University; M.S., Ohio State University;
Ph.D., Arizona State University
- Smith, Ronald D. (1963) *Assistant Professor of History*
A.B., San Diego State College; Ph.D., University of Southern California
- Smith, Rose M. (1967) *Assistant Professor of Speech and Theatre*
B.A., Oklahoma College for Women; A.M., University of Michigan
- Snapp, Kenneth O. (1970) *Professor of Music*
B.M., University of Miami; M.M., University of Michigan;
Ph.D., Indiana University
- Snelling, Robert D. (1969) *Assistant Professor of Speech and Theatre*
B.A., Whitman College; M.A., Stanford University
- Snider, Donald L. (1967) *Associate Professor of Engineering*
B.S., California State Polytechnic College; M.S., University of Pennsylvania;
Ph.D., Case Institute of Technology
- Snow, Robert P. (1970) *Assistant Professor of Sociology*
B.S., M.A., Ph.D., University of Minnesota
- Snyder, Ernest E., Jr. (1958) *Professor of Science Education*
A.B., M.A., Colorado State College; Ed.D., New York University
- Snyder, James F. (1970) *Assistant Professor of Business Administration*
B.S., Bloomsburg State College; M.Ed., Montclair State College;
Ph.D., University of Georgia
- Snyder, Lester M. (1967) *Associate Professor of Education*
B.S., Millersville State College; M.Ed., Western Maryland College;
Ph.D., University of Michigan
- Soderberg, Richard R. (1969) *Professor of Agricultural Management;*
Director, Division of Agriculture
B.S., M.S., University of Southern California
- Sommerfeld, Milton R. (1968) *Assistant Professor of Botany*
B.S., Southwest Texas State Teachers College; Ph.D., Washington University
- Sorensen, Kenneth C., Capt. (1970) *Assistant Professor of*
Military Science
B.S., University of Utah
- Sorvig, Richard D. (1970) *Assistant Professor of Speech and Theatre*
B.A., Bethel College; M.A., University of Minnesota
- Spinosa, Frank (1965) *Associate Professor of Music*
B.M., M.A., Boston University; D.M.A., University of Illinois
- Stadtmiller, Jack E. (1963) *Associate Professor of Engineering*
Communications; Coordinator of Student Advisement,
College of Engineering Sciences
B.A., University of Utah; M.A., Arizona State University
- Stafford, Alfred B. (1958) *Professor of Engineering*
B.S.E.E., Carnegie Institute of Technology; M.A., University of Pittsburgh;
Ph.D., University of Chicago
- Stafford, Kenneth (1957) *Professor of Education*
B.A., M.Ed.D., Ph.D., University of Oklahoma
- Stahnke, Herbert L. (1941) *Professor of Zoology;*
Director, Poisonous Animals Research Laboratory
S.B., University of Chicago; M.A., University of Arizona;
Ph.D., Iowa State University

- Staley, Frederick A. (1970) *Assistant Professor of Education*
B.A., M.A., Western Michigan University; Ph.D., Michigan State University
- Stalzer, Frank S. (1955) *Associate Professor of Music*
B.M.Ed., University of Kansas; M.M., Eastman School of Music
- Stange, Jean B. (1970) *Associate Professor of Home Economics*
B.S., Iowa State University; M.S., University of Minnesota
- Stanley, James T. (1968) *Associate Professor of Engineering*
B.S., M.S., Ph.D., University of Illinois
- Stapleton, Margaret L. (1969) *Instructor in Nursing*
B.S., Arizona State University; M.S., University of California, Los Angeles
- Stauder, Jack (1971) *Assistant Professor of Anthropology*
B.A., Harvard University; B.A., M.A., Ph.D., Cambridge University (England)
- Steere, Caryl J. (1960) *Assistant Professor of Education*
B.A., Albion College; M.A., Arizona State University
- Steffl, Bernita M. (1961) *Associate Professor of Nursing*
R.N., Ancker Hospital School of Nursing; B.S. in P.H.N., M.P.H.,
University of Minnesota
- Stein, Peter K. (1959) *Professor of Engineering*
S.B. (Bus. Adm.), S.B.M.E., M.S., Massachusetts Institute of Technology
- Steinmann, Wilbur L. (1959) *Associate Professor of Engineering*
B.E.E., University of Minnesota; M.S.E.E., State University of Iowa
- Stellhorn, Martin (1963) *Professor of Music*
Mus.B., St. Louis Institute of Music; Mus.M., Northwestern University;
Ph.D., Washington University
- Stengel, Jean M. (1970) *Instructor in Nursing*
B.S.N., University of Oregon Medical School; M.A., University of Minnesota
- Sterling, William H. (1970) *Assistant Professor of Art*
A.B., College of William and Mary; Ph.D., State University of Iowa
- Stevenson, Harold W. (1967) *Professor of Finance*
B.S., University of Minnesota; M.B.A., Ph.D., University of Michigan; C.F.A.
- Steverson, Norris J. (1932) *Associate Professor of*
Health, Physical Education and Recreation
B.A. in Ed., Arizona State University; M.S. in Ed., University of
Southern California
- Stewart, Donald G. (1964) *Assistant Professor of Mathematics*
B.A., M.S., University of Utah; Ph.D., University of Tennessee
- Stewart, Ernest I., Jr. (1959) *Professor of Health Education;*
Associate Dean, College of Liberal Arts
B.S., M.S., Utah State University; Ph.D., Columbia University
- Stewart, Kenneth M. (1947) *Professor of Anthropology*
A.B., M.A., Ph.D., University of California, Berkeley
- Stiles, Philip G. (1969) *Professor of Poultry Science*
B.S., University of Arkansas; M.S., University of Kentucky;
Ph.D., Michigan State University
- Stites, William H. (1954) *Professor of Speech and Theatre*
B.A., Louisiana Polytechnic Institute; M.A., Ph.D., University of Denver
- Stone, William J. (1967) *Associate Professor of Health,*
Physical Education and Recreation
B.S., Boston University; M.S., Florida State University;
Ed.D., University of California, Berkeley
- Stoner, Richard G. (1963) *Professor of Physics;*
Chairman, Department of Physics
A.B., A.M., Ph.D., Princeton University
- Stout, Irving W. (1953) *Professor of Education*
B.Ed., Wisconsin State University; M.A., Ed.D., Northwestern University
- Stout, Minard W. (1968) *Professor of Education;*
Director, Center for Higher Education
B.A., University of Northern Iowa; M.A., Ph.D., State University of Iowa
- Stowe, Noel J. (1967) *Assistant Professor of History*
B.A., Ph.D., University of Southern California
- Straub, Calvin C. (1961) *Professor of Architecture*
B.Arch., University of Southern California
- Streufert, Hildegard (1961) *Associate Professor of Home Economics*
B.S., University of Minnesota; M.S., Iowa State University
- Strojnik, Ales (1969) *Professor of Physics*
Diplom. Ing., Ph.D., University of Ljubljana (Yugoslavia)
- Strom, Robert D. (1969) *Professor of Education;*
Chairman, Department of Elementary Education
B.S., Macalester College; M.A., University of Minnesota;
Ph.D., University of Michigan
- Strong, Robert E., Jr. (1969) *Assistant Professor of Law*
A.B., Stanford University; LL.B., Harvard University
- Stuler, John H. (1963) *Assistant Professor of Art*
B.A., M.F.A., Arizona State University
- Stumpf, Angela M. (1959) *Associate Professor of Nursing*
R.N., St. Mary's Hospital School of Nursing, Milwaukee;
B.S.N.E., Marquette University; M.A., University of Chicago
- Stutsman, Paul S. (1967) *Associate Professor of Chemistry*
B.S., University of Illinois; Ph.D., University of Wisconsin
- Sukut, Arlyn A., Major (1969) *Assistant Professor*
of Aerospace Studies
B.S., North Dakota State University; M.B.A., University of Missouri
- Sundwall, Harry W. (1962) *Professor of Education;*
Director, Center for Indian Education
B.S., Brigham Young University; Ph.D., University of California, Berkeley
- Susel, Rudolph M. (1970) *Assistant Professor of History*
B.A., Heidelberg College; M.A., University of Indiana

- Sutton, Dwight (1963) *Associate Professor of Psychology*
B.S., M.S. (Educ.), M.S. (Psych.), University of Idaho;
Ph.D., University of California, Berkeley
- Svoboda, William S. (1969) *Associate Professor of Education*
B.S. in Ed., M.S., Ed.D., University of Kansas
- Swagert, S. Laird (1969) *Professor of Political Science*
B.Ed., Western Illinois State Teachers College;
M.A., Ph.D., State University of Iowa
- Swanson, Roger M. (1968) *Assistant Professor of English*
A.B., North Central College; A.M., Ph.D., University of Illinois
- Swimmer, Alvin (1963) *Assistant Professor of Mathematics*
B.A., Pennsylvania State University; M.S., New York University;
Ph.D., University of California, Berkeley
- Talbert, Elmer G. (1968) *Assistant Professor of Education*
B.A., University of Wyoming; M.Ed., Colorado State University;
Ed.D., University of Oklahoma
- Tamba, Lewis A. (1969) *Associate Professor of History*
B.S., University of California, Berkeley; M.A., Ph.D., University of
California, Santa Barbara
- Tanara, Albert A., Jr. (1970) *Instructor in Health, Physical
Education and Recreation; Assistant Football Coach*
B.S., University of Tennessee
- Tate, Donald J. (1958) *Professor of Office Administration and
Business Education*
B.S., Kansas State Teachers College; M.A., Ed.D., New York University
- Taylor, Benjamin J. (1966) *Professor of Economics;
Chairman, Department of Economics*
B.S., Oakland City College; M.A., Indiana State University;
Ph.D., Indiana University
- Taylor, Eugene M. (1964) *Assistant Professor of Psychology*
B.S., Idaho State College; M.S., Ph.D., University of Washington
- Taylor, Jack J. (1960) *Professor of Art*
B.S. in Art Ed., State Teachers College, Kutztown, Pa.;
M.Ed., Pennsylvania State University
- Taylor, Louis (1949) *Assistant Professor Emeritus of English*
B.S. in Ed., M.A., Ohio State University
- Taysom, Elvin D. (1953) *Professor of Animal Science*
B.S., University of Idaho; M.S., Utah State University;
Ph.D., Washington State University
- Tenney, Lester I. (1969) *Assistant Professor of Insurance*
B.A., University of Miami; M.A., San Diego State College
- Teubner, John (1969) *Instructor in Social Work*
B.A., Gannon College; M.S.W., St. Louis University
- Theobald, Clarabelle (1962) *Associate Professor of Nursing*
R.N., Methodist Hospital School of Nursing; B.S., Arizona State University;
M.S., University of California, Los Angeles
- Thomas, Charles S. (1968) *Associate Professor of Education*
B.S., M.S., Ohio University; Ed.D., University of Pennsylvania
- Thomason, Leslie L. (1969) *Professor of Technology*
A.B., M.A., Ed.D., University of Oklahoma
- Thompson, Harry L. (1966) *Assistant Professor of Construction*
B.S., Arizona State University
- Thompson, Jerry W. (1967) *Instructor in Health,
Physical Education and Recreation; Assistant Football Coach*
B.S.B.E., University of Oklahoma
- Thompson, Lee P. (1955) *Professor of Engineering; Dean, College of
Engineering Sciences; Director, School of Engineering; Director,
Engineering Research Center; Director, University Computer Center*
B.A., Indiana University; M.S., Ph.D., Texas A&M University
- Thompson, Truet B. (1959) *Professor of Engineering*
B.S., B.S.E.E., Louisiana Polytechnic Institute; M.S., Oklahoma State University;
Ph.D., Northwestern University
- Thompson, Wilma M. (1959) *Instructor in Mathematics*
A.B., New Mexico Highlands University; M.S., University of Wyoming
- Thomson, A. Brian (1963) *Lecturer in Engineering;
Manager, Computer Center*
B.S., University of Glasgow (Scotland); M.S., Arizona State University
- Thomson, Ronald G. (1947) *Professor of Health, Physical
Education and Recreation; Vice Chairman, Department
of Health, Physical Education and Recreation*
B.S., Springfield, College; M.A. in Ed., Arizona State University;
Ed.D., University of Southern California
- Thomson, Tom R. (1961) *Professor of Chemistry*
B.A., University of California, Berkeley; M.S., Ph.D., Kansas State University
- Tice, Cynthia S. (1968) *Assistant Professor of Nursing*
R.N., Chicago Wesley Memorial Hospital; B.A., College of Wooster;
M.S., Wayne State University
- Tice, Thomas E. (1967) *Professor of Engineering;
Chairman, Electrical Engineering Faculty*
B.E.E., M.S., Ph.D., Ohio State University
- Tilden, Arnold (1937) *Professor of History*
B.A., M.A., DePauw University; Ph.D., University of Southern California
- Tingey, Sherman N. (1966) *Associate Professor of Management*
B.S., Utah State University; M.B.A., Golden Gate College;
D.B.A., University of Washington
- Tipton, Gary (1969) *Assistant Professor of Chinese*
B.A., Brigham Young University

- Toohey, Jack V. (1966) *Professor of Health, Physical Education and Recreation*
 B.A., Arizona State University; M.S.E., University of Illinois;
 M.S., Northern Arizona University; Ed.D., Arizona State University
- Tootle, John C. (1967) *Associate Professor of Business Administration*
 B.S., Georgia Southern College; M.A., George Peabody College;
 Ph.D., Ohio State University
- Toth, Richard P., SFC (1969) *Assistant Professor of Military Science*
- Tuberose, Anthony M. (1968) *Associate Professor of Finance*
 B.S., M.A., Florida State University; Ph.D., University of Texas, Austin
- Turk, Rudy H. (1967) *Associate Professor of Art; Director, University Art Collections*
 B.S., University of Wisconsin; M.A., University of Tennessee
- Turnbow, James W. (1959) *Professor of Engineering*
 B.S.M.E., Texas Technological College; M.S. in E.M., Ph.D., University of Texas
- Turner, Christy G., II (1966) *Associate Professor of Anthropology*
 B.A., M.A., University of Arizona; Ph.D., University of Wisconsin
- Turner, Katharine C. (1946) *Professor of English*
 B.Ed., Illinois State Normal University; M.A., Ph.D., University of Michigan
- Uhl, Raymond (1959) *Professor of Political Science*
 B.A., M.A., University of Virginia; Ph.D., Johns Hopkins University
- Valdivieso, L. Teresa (1971) *Instructor in Spanish*
 B.A. Ed., M.A. Ed., Arizona State University
- Van Petten, Donald R. (1942) *Professor Emeritus of Political Science*
 A.B. in Ed., Arizona State University; M.S. in Ed., University of Southern California; Ph.D., Stanford University
- Van Scoy, Herbert A. (1963) *Professor of Spanish*
 B.A., M.A., University of Alabama; Ph.D., University of Wisconsin
- Van Wagenen, R. Keith (1963) *Professor of Education*
 B.A., Pacific Union College; M.A. in Ed., Arizona State University;
 Ph.D., University of Utah
- Veatch, Jeannette (1968) *Professor of Education*
 A.B., Western Michigan University; M.A., Ph.D., New York University
- Venable, Gilbert T. (1970) *Assistant Professor of Law; Assistant Dean, College of Law*
 B.A., Cornell University; J.D., University of Pittsburgh
- Vergis, John P. (1954) *Professor of Education*
 B.S., M.A., New York University; Ed.D., University of Southern California
- Vichules, Leo D. (1961) *Assistant Professor of Political Science*
 A.B., M.A., University of Michigan
- Vickers, Samuel E. *Professor of Political Science; Director, Center for Urban Studies*
 B.S., South Dakota State School of Mines; M.B.A., Northwestern University
- Virgillo, Carmelo (1965) *Associate Professor of Romance Languages*
 A.B., State University of New York; A.M., Ph.D., Indiana University
- von Bretzel, Philip K. (1967) *Assistant Professor of Philosophy*
 B.A., M.A., University of Michigan
- von der Heydt, Alfred (1950) *Professor of German*
 Diploma, University of Frankfurt-on-the-Main, Germany;
 M.A., Yale University; Ph.D., Cornell University
- Voss, Howard G. (1964) *Assistant Professor of Physics*
 A.B., Hope College; M.N.S., Arizona State University; M.S., Purdue University
- Votichenko, T. Alexander (1956) *Assistant Professor of Philosophy*
 A.B., Princeton University; M.A., Columbia University
- Wagner, Merry L. (1969) *Instructor in English*
 B.A., M.A., Arizona State University
- Wagner, Ronald F. (1962) *Associate Professor of Art*
 B.S., University of Wisconsin; M.F.A., State University of Iowa
- Wagstaff, H. Reid (1969) *Associate Professor of Geography*
 A.B., A.M., Ph.D., University of Michigan
- Walker, Charles Thomas (1971) *Professor of Physics*
 A.B., M.S., University of Louisville; Ph.D., Brown University
- Walker, Janet F. (1960) *Professor Emeritus of Nursing*
 R.N., St. John's Hospital School of Nursing; B.S., Western Reserve University;
 M.S., Catholic University of America
- Walker, John E. (1970) *Assistant Professor of Education*
 B.A., Albion College; M.A., Michigan State University
- Walker, Richard B., Capt. (1970) *Assistant Professor of Military Science*
 B.S., Indiana University
- Walker, Stephen G. (1969) *Assistant Professor of Political Science*
 A.B., Creighton University; M.A., University of Florida
- Wallace, Charles E. (1958) *Professor of Engineering; Chairman, Engineering Mechanics and Materials Faculty*
 B.S., Lewis and Clark College; M.S., Oregon State University;
 Ph.D., Stanford University
- Walters, David H. (1969) *Instructor in Music*
 B.M., M.M., Michigan State University
- Wang, Alan P. (1970) *Associate Professor of Mathematics*
 B.S., Washington State University; M.S., University of Southern California;
 Ph.D., University of California, Los Angeles
- Ward, Harold L., SSG (1969) *Assistant Professor of Military Science*
- Ward, Jack W. (1964) *Associate Professor of Construction*
 B.S. in C.E., University of Idaho

- Warren, Dolores (1968) *Assistant Professor of Nursing*
B.S., Texas Women's University; M.S., University of California, San Francisco
- Warren, Morrison F. (1968) *Associate Professor of Education;*
Director, I. D. Payne Learning Laboratory
B.A., M.A., Ed.D., Arizona State University
- Waskey, Frank H. (1969) *Instructor in Home Economics*
B.S., Cornell University; M.S., State University College, Oneonta, New York
- Wasser, Paula K. (1927) *Professor Emeritus of Art*
B.S. in Ed., University of North Dakota; M.A., Stanford University
- Watson, George L. (1969) *Assistant Professor of Political Science*
B.A., Phillips University; M.A., Duke University
- Weber, Barbara (1971) *Assistant Professor of Humanities*
B.A., M.A., Ph.D., Florida State University
- Weber, Delbert D. (1962-66; 1969) *Professor of Education;*
Dean, College of Education
B.A., Midland College; M.Ed., Ed.D., University of Nebraska
- Wegner, Artroll L. (1957) *Professor of Health,*
Physical Education and Recreation
B.S., Wisconsin State College; M.S., University of Wisconsin;
P.E.D., Indiana University
- Weiner, Gordon M. (1968) *Assistant Professor of History*
A.B., Ph.D., University of Pennsylvania
- Weiss, Neil A. (1970) *Assistant Professor of Mathematics*
B.A., M.A., Ph.D., University of California, Los Angeles
- Weitzel, Marlene H. (1970) *Assistant Professor of Nursing*
R.N., St. Francis Hospital School of Nursing; B.S.N., Duchesne College;
M.S.N., Catholic University of America
- Welch, H. William (1967) *Professor of Engineering;*
Assistant Dean, College of Engineering Sciences
B.A., DePauw University; M.S., Ph.D., University of Michigan
- Wexler, Charles (1930) *Professor of Mathematics*
S.B., A.M., Ph.D., Harvard University
- Whiffen, Marcus (1960) *Professor of Architecture*
B.A., M.A., University of Cambridge (England)
- Whitam, Frederick L. (1966) *Associate Professor of Sociology*
B.A., Millsaps College; A.M., Ph.D., Indiana University
- White, Harold C. (1966) *Associate Professor of Management*
B.S., M.S., University of Oregon; Ph.D., University of Florida
- White, John P. (1963) *Professor of Political Science;*
Chairman, Department of Political Science
A.B., University of Cincinnati; A.M., Ph.D., University of Chicago
- Whitehurst, Harry B. (1959) *Professor of Chemistry*
B.A., M.A., Ph.D., Rice University
- Wilcox, Sidney W. (1955) *Professor of Engineering Communications*
B.A., Bethany-Peniel College; M.A., University of Oklahoma
- Wilkinson, Joseph W. (1964) *Associate Professor of Accounting*
B.S., Carnegie Institute of Technology; M.B.A., Stanford University;
D.P.A., University of Oregon; C.P.A., California
- Willson, Loretta L. (1947) *Assistant Professor of Speech and Theatre*
B.A., University of South Dakota; M.A., Northwestern University
- Wilson, Gloria N. (1961) *Assistant Professor*
of Business Administration
B.A., Montclair State College; M.A., Ed.D., Teachers College,
Columbia University
- Wilson, Irma (1922) *Professor Emeritus of Spanish*
A.B., University of Montana; A.M., Ph.D., Columbia University
- Wilson, Lorna A. (1968) *Instructor in French*
B.Ed., University of Saskatchewan; M.A., Arizona State University
- Wilson, Lynn D. (1961) *Professor of Engineering*
B.S., M.S., Ph.D., Marquette University
- Wilt, Glenn A., Jr. (1963) *Associate Professor of Finance*
A.B., Occidental College; M.B.A., Miami University;
Ph.D., University of Michigan; C.F.A.
- Winkelman, Richard D. (1965) *Associate Professor of Economics*
A.B., Southern Illinois University; A.M., Ph.D., University of Illinois
- Winkles, Bobby B. (1958) *Instructor in Health,*
Physical Education and Recreation; Baseball Coach
B.Ph., Illinois Wesleyan University; M.S., University of Colorado
- Wirtz, Dorothy (1959) *Professor of French*
B.A., State University of Iowa; M.A., Ph.D., University of Wisconsin
- Witt, Daniel (1966) *Associate Professor of Speech and Theatre*
B.F.A., Art Institute of Chicago; M.A., Ph.D., University of Denver
- Wochner, Raymond E. (1952) *Professor of Education; Chairman,*
Department of Educational Administration and Supervision
B.S., York College; M.A., University of Nebraska; Ph.D., University of Wyoming
- Wolf, Donald J. (1969) *Associate Professor of Political Science*
B.A., M.A., Gonzaga University; S.T.M., Santa Clara University;
Ph.D., Georgetown University
- Wolfgang, Steven W., Capt. (1969) *Assistant Professor*
of Military Science
B.S., University of Wisconsin
- Wollam, Owen A. (1964) *Assistant Professor of French*
B.A., M.A., Montana State University; Ph.D., University of Washington
- Wood, Byard D. (1970) .. *Assistant Professor of Mechanical Engineering*
A.A., Boise College; B.S.M.E., M.S.M.E., Utah State University;
Ph.D., University of Minnesota
- Wood, Harry (1954) *Professor of Art*
B.A., M.A., University of Wisconsin; B.A., Ph.D., Ohio State University

Woodfill, Marvin C. (1966) *Associate Professor of Engineering*
 B.S., M.S., Ph.D., Iowa State University

Woodman, Natalie J. (1969) *Assistant Professor of Social Work*
 B.A., Washington Square College of New York University; M.S.S., Smith
 College School for Social Work; Post-Master's study, University of
 Chicago School of Social Service Administration

Woods, Roosevelt, Jr. (1965) *Assistant Professor of Art*
 B.S., M.A. in Ed., Arizona State University

Woody, Robert W. (1969) *Associate Professor of Chemistry*
 B.S., Iowa State University; Ph.D., University of California, Berkeley

Wooldridge, Charles B. (1959) *Associate Professor of Engineering*
 A.B., B.S., University of Kentucky; M.S., Ph.D., Purdue University

Wooldridge, Donn G. (1968) *Assistant Professor of Architecture*
 B.Arch., B.Arch.Engr., M.Arch.Engr., Oklahoma State University

Wooldridge, Mary C. (1959) *Assistant Professor of Home Economics*
 B.S., M.S., University of Kentucky

Woolf, Charles M. (1961-63; 1964) *Professor of Zoology*
 B.S., M.S., University of Utah; Ph.D., University of California, Berkeley

Wootten, William W. (1959) *Associate Professor of History*
 B.A., University of Chicago; M.A., State University of Iowa;
 Ph.D., University of Minnesota

Wootton, Richard T. (1964) *Professor of Education;*
Director, Financial Aids
 B.S., M.S., Ed.D., University of Utah

Work, Richard N. (1965) *Professor of Physics;*
Associate Dean, College of Liberal Arts
 A.B., M.S., Ph.D., Cornell University

Wright, Robert G. (1967) *Associate Professor of Management*
 B.S., California State Polytechnic College; M.B.A., D.B.A., University of
 Southern California

Wulk, Ned W. (1957) *Assistant Professor of Health,*
Physical Education and Recreation; Head Basketball Coach
 B.S., LaCrosse State College; M.Ed., Xavier University

Wurzell, Carol A. (1965) *Assistant Professor of Nursing*
 B.S., Chico State College; M.S., University of Maryland

Yale, Francis G. (1952) *Associate Professor of Science Education*
 A.B., M.A., Colorado State College of Education; Ed.D., Columbia University

Yeater, James W. (1958) *Associate Professor of Speech and Theatre;*
Director, University Theatre
 B.A., Baker University; M.A., University of Washington;
 Ph.D., University of Illinois

Young, Colin M. (1970) *Assistant Professor of Architecture*
 A.A. Diploma, Architectural Association School, London;
 M.L.A., University of Pennsylvania

Young, Hewitt H. (1967) *Professor of Engineering;*
Chairman, Industrial Engineering Faculty
 B.S.M.E., M.S.I.E., Case Institute of Technology; Ph.D., Arizona State University

Young, Otis E, Jr. (1963) *Professor of History*
 A.B., A.M., Ph.D., Indiana University

Yuen, George U. (1957) *Professor of Chemistry*
 B.S., Arizona State University; Ph.D., University of Utah

Zacher, Robert V. (1947) *Professor of Advertising*
 B.S. in B.A., M.S. in B.A., University of Alabama

Zaslow, Bertram (1956) *Professor of Chemistry*
 B.A., Cornell University; M.S., University of Minnesota;
 Ph.D., Iowa State University

Zauh, Fredric E. (1969) *Instructor in English*
 B.A., Northwestern University; M.A., Arizona State University

Zesbaugh, Joseph P. (1969) *Instructor in Mass Communications*
 B.A., Wisconsin State University at Eau Claire; M.A., State University of Iowa

Zimmer, Carl R. (1959) *Associate Professor of Engineering*
 B.E.E., Cornell University; M.E.E., Ph.D., Syracuse University

Zimmerman, J. E. (1946) *Professor of English*
 A.B., M.A., Baylor University

Zimmerman, Muriel Ann (1968) *Assistant Professor of Art*
 B.A., Queens College; M.A., M.F.A., Ph.D., Arizona State University

Zoll, Donald A. (1970) *Professor of Political Science*
 B.A., Knox College; M.A., Northwestern University;
 M.A., D. Litt., University of Saskatchewan

Zornow, Ruth A. (1970) *Assistant Professor of Nursing*
 B.S., Western Reserve University; M.Ed., Ed.D., Columbia Teachers College

Visiting Professors and Lecturers

Abeyta, Nicholas P. *Clinical Associate Professor of Education*
 B.S., College of St. Joseph; M.A., Ed.D., University of New Mexico

Anderson, Marlowe R. *Lecturer in Technology*
 B.S.E.E., University of Colorado

Cain, H. Thomas *Lecturer in Anthropology*
 A.B., University of Washington; M.A., University of Arizona

Canter, Aaron H. *Clinical Professor of Education*
 B.A., Brooklyn College; M.A., Columbia University;
 Ph.D., Teachers' College, Columbia University

Christensen, George W. *Lecturer in Architecture*

Clark, Julian H. *Lecturer in Architecture*

Cullum, Leslie E. *Lecturer in Zoology;*
Head Curator, Animal Resource Center
 Certificate, Institute of British Surgical Technicians

VISITING PROFESSORS AND LECTURERS

- De Bolske, Jack *Lecturer in Political Science*
B.A., Loyola College; M.P.A., University of California, Los Angeles
- Edlin, Frank E. *Lecturer in Engineering*
B.S., Kansas State University
- Ekblaw, Sidney E. *Visiting Professor of Geography*
A.B., M.S., University of Illinois; Ph.D., Clark University
- English, Fenwick *Visiting Lecturer in Education*
B.A., M.A., University of Southern California
- Fireman, Bert M. *Lecturer in History;*
Curator of the Arizona Collection
B.A., Arizona State University
- Fleming, Donovan E. *Visiting Associate Professor of Psychology*
B.S., M.S., Brigham Young University; Ph.D., Washington State University
- Green, John R. *Lecturer in Zoology*
B.S., College of Puget Sound; M.B., M.D., Northwestern University
- Gruber, Gabriel *Lecturer in Music*
Diploma, Juilliard School of Music
- Harris, Joseph *Research Professor of Chemistry*
B.S., University of Maryland; M.A., Ph.D., Johns Hopkins University
- Hay, Donal L. *Lecturer in Technology*
B.A.S.E., M.A., Arizona State University
- Holmes, Leslie A. *Visiting Professor of Geography*
B.S., M.S., Ph.D., University of Illinois
- Kronegold, Eric A. *Visiting Instructor in Art*
B.A., M.A., San Francisco State College
- Larson, Mildred R. *Visiting Lecturer in English*
B.A., M.A., New York State College for Teachers at Albany;
Ph.D., New York University
- Leftwich, Billy *Lecturer in Architecture*
- Levy, Barbara *Visiting Associate Professor of Psychology*
A.B., Ph.D., University of California, Berkeley
- Lindberg, Robert E. *Clinical Professor of Education*
B.A., University of Minnesota; M.Ed., University of Missouri;
Ph.D., Arizona State University
- Lytel, Robert G. *Lecturer in Agriculture*
B.S., Western Kentucky University
- McDowell, Edwin *Lecturer in Mass Communications*
B.A., Temple University
- Malfetti, James L. *Visiting Professor of Health,*
Physical Education and Recreation
B.S., College of the City of New York; M.S., Ed.D., Columbia University
- Manera, Elizabeth S. *Visiting Lecturer in Education*
B.S., Towson State College; M.A., Ed.D., Arizona State University
- Minter, Marshall R., Jr. *Lecturer in Industrial Design*
B.S.M.E., Purdue University
- Nesby, Robert N. *Lecturer in History*
B.A., University of Colorado; B.D., Colgate Rochester Divinity School;
M.A., Arizona State University
- Petti, John (1971) *Clinical Professor of Education*
B.S.Ed., Youngstown University; M.A., University of Chicago;
Ph.D., Arizona State University
- Piltz, Robert J. *Visiting Associate Professor of Psychology*
B.A., M.A., University of Missouri; Ph.D., Vanderbilt University
- Reed, William H. *Lecturer in Technology*
B.S., University of Oklahoma
- Roberts, Ethel T. *Visiting Lecturer of Education*
B.A., M.A., M.A. in Ed., Arizona State University
- Roper, Devon J. *Lecturer in Technology*
B.S., Utah State University
- Ruiter, William W. *Lecturer in Technology*
B.S., University of Oregon; M.S., Oregon State University
- Sakiotis, Nicholas G. *Lecturer in Engineering*
B.E.E., College of The City of New York
- Scalise, James W. *Lecturer in Architecture*
- Schoen, Robert A. *Lecturer in Technology*
B.S., Arizona State University
- Soleri, Paolo *Lecturer in Architecture*
Professor of Design, Liceo Artistico Torino; Dottore in Architettura,
Politechnic of Turin
- Sperstad, Marlowe L. *Lecturer in Technology*
B.S. in Ind. Ed., M.S. in Voc. Ed., Stout State University
- Swagert, S. Laird *Visiting Professor in Political Science*
B.Ed., Western Illinois State Teachers College; M.A.,
Ph.D., State University of Iowa
- Swafford, James R. *Lecturer in Microbiology*
- Taylor, Anne Parker *Lecturer in Architecture*
- Verner, Erva J. *Lecturer in Education*
B.A., University of Wisconsin; M.A., Arizona State University
- Warnicke, Retha M. *Lecturer in History*
A.B., Indiana University; A.M., Ph.D., Harvard University
- Weeks, Willis E. *Lecturer in English*
B.A., M.A., Oklahoma City University
- Weiss, Barry W. *Visiting Assistant Professor of Psychology*
B.A., Brooklyn College; Ph.D., State University of New York

- Wrenn, C. Gilbert *Visiting Professor of Counselor Education*
 A.B., Willamette University; M.A., Ph.D., Stanford University;
 LL.D., Willamette University
- Yellott, John I. *Lecturer in Architecture*
 B.S., M.M.E., Johns Hopkins University

University Library

- Axford, H. William (1970) *University Librarian; Professor*
 A.B., Reed College; M.A., Ph.D., University of Denver
- Albright, Robert W. (1966) *Reference Librarian*
 A.B., University of Washington; M.L.S., Indiana University;
 A.M., Ph.D., Stanford University
- Beecher, Mary E. (1958) *Catalog Librarian*
 B.A., State College of Iowa; M.A., State University of Iowa
- Borovansky, Vladimir T. (1968) *Chief Science Librarian*
 M.L.S., Charles University (Prague, Czechoslovakia)
- Danaher, Edward M. (1968) *Assistant University Librarian*
 Ph.D., Marquette University; M.A., University of Denver
- DeFato, Rosalinda (1970) *Reference Librarian*
 B.A., St. John's University College; M.L.S., University of California, Los Angeles
- Dial, Zona P. (1966) *Reference Coordinator*
 B.A., University of Arizona; M.A., University of Denver
- Dobbins, Jenny L. (1967) *Assistant Head, Catalog Service*
 A.B., M.A., Indiana University
- Dobkin, Joseph B. (1970) *Head, Technical Services*
 B.A., University of Florida; M.L.S., Rutgers, The State University
- Ferrall, Eleanor J. (1969) *Reference Librarian*
 A.B., Heidelberg College
- Fireman, Bert M. (1967) *Curator, Arizona Collection*
 B.A., Arizona State University
- Haskell, Donna M. (1963) *Head, Catalog Service*
 B.S. in Ed., Kansas State Teachers College; A.M.L.S., University of Michigan
- Henning, Jane C. (1968) *Special Librarian, Architecture*
 B.A., Indiana University
- Jardine, Marilyn (1967) *Head, Interlibrary Loan*
 B.A., University of Portland; M.L.S., University of Washington
- Johnson, Karl B. (1968) *Head, Special Collections*
 A.B., University of Arizona; M.A., University of Denver
- Kessler, Holly G. (1966) *Catalog Librarian*
 B.S., State Teachers College, Geneseo, N.Y.; M.S., Syracuse University
- Knepp, Kenneth (1968) *Catalog Librarian*
 B.A., University of the Pacific; B.D., Garrett Theological Seminary;
 M.A., University of Denver

- Kusche, Larry D. (1969) *Reference Librarian*
 B.A., M.A., Arizona State University; M.A., University of Denver
- Lewis, Evelyn (1969) *Head, Bibliography Service*
 B.A., University of Florida; M.S., Florida State University
- Martinez, Linda (1966) *Head, Special Services*
 B.S., Oregon State University; M.A.L.S., University of Michigan
- Mayhew, Helen (1970) *Assistant Head, Acquisitions Service*
 B.A., Fort Hays Kansas State College; M.A., University of Denver
- McColgin, Ronda L. (1970) *Catalog Librarian*
 B.A., Arizona State University; M.S.L.S., University of Southern California
- McDonald, Arlys L. (1970) *Special Librarian, Music*
 B.M., St. Mary of the Plains; M. Mus., University of Illinois
- McGrath, Afton L. (1966) *Special Librarian, Business Administration*
 B.A., Arizona State University; M.L.S., University of California, Berkeley
- Muir, Gertrude F. (1960-62; 1963) *Reference Librarian*
 B.A., M.A., University of Arizona; B.S., University of Denver
- Nicewarner, Metta L. (1970) *Catalog Librarian*
 B.A., Hardin-Simmons University; M.L.S., University of Texas, Austin
- Palais, Elliot S. (1959-62; 1966) *Reference Librarian*
 A.B., Bowdoin College; A.M.L.S., University of Michigan
- Picca, David (1970) *Head, Acquisitions Service*
 M.A.L.S., Immaculate Heart College, Lawrea de Dottore, Oriental
 University, Institute of Naples
- Rawson, Ruth P. (1958) *Reference Librarian*
 B.S., Certificate in L.S., University of Minnesota
- Ruppé, Carol V. (1962) *Reference Librarian*
 B.A., University of New Mexico; M.A., University of Denver
- Sanders, Nancy P. (1970) *Head, Government Documents*
 B.A., Kansas University; M.A., University of Denver
- Schneberger, Lois I. (1969) *Catalog Librarian*
 B.A., Viterbo College; M.L.S., Kansas State Teachers College
- Smith, Mary M. (1970) *Head, Serials Records Service*
 B.A., University of South Dakota; M.A., University of Minnesota
- Sprague, Oren W. (1967) *Reference Librarian*
 B.A., Graceland College; B.D., Drake University; M.L.S., University
 of California, Los Angeles
- Stewart, Karen J. (1970) *Reference Librarian*
 B.A., Pennsylvania State University; M.L.S., University of Pittsburgh
- Swaty, Mary A. (1968) *Catalog Librarian*
 B.A., University of Missouri; M.L.S., Indiana University
- Thomas, Barbara A. (1968) *Assistant Head, Catalog Service*
 A.B., Fort Hays Kansas State College; M.A., University of Denver

- Watrous, Lyle C. (1962) *Assistant Reference Coordinator*
 A.B., University of North Carolina; B.S.L.S., Carnegie Institute of Technology;
 M.A., Arizona State University
- Wu, Ai-Hwa (1964) *Catalog Librarian*
 B.S., National Taiwan University (China); M.L.S., University of Washington
- Wurzburger, Marilyn J. (1960) *Catalog Librarian*
 A.B., MacMurray College

Law Library

- Dahl, Richard C. (1966) *Director*
 B.A., B.L.S., University of California, Berkeley; LL.B., Catholic University
- Au, Chih-Chun (1970) *Cataloger*
 B.A., National Taiwan University; M.A., University of Chicago
- Moloso, Michael R. (1970) *Acquisitions Librarian*
 B.A., Whitman College; M.L.S., University of Denver
- Nelson, John D. (1969) *Assistant Law Librarian*
 B.A., University of Minnesota; J.D., William Mitchell College of Law;
 M.S.L.S., University of Wisconsin
- Sinsabaugh, Suzanne Willard (1970) *Documents Librarian*
 B.A., Wheaton College; M.L.S., Simmons College; J.D., University of Arizona

Student Health Service

- Jones, Richard L. (1968) *Director*
 B.S., Purdue University; M.D., University of Arkansas
- Dorner, Arthur F., F.A.C.S. (1961) *Associate Director*
 A.B., Ohio Wesleyan University; M.D., Western Reserve University
- McFarland, Elaine (1946) *Assistant Director*
 B.A., Marietta College; M.N., C.P.H.N., Western Reserve University
- Baker, Charles J., F.A.C.P. (1970) *University Physician*
 A.B., Tufts College; M.D., Cornell University; American Board of Pediatrics
- Gentner, George A., F.A.C.R. (1964) *Consulting Roentgenologist, P/T*
 M.D., University of Buffalo; Diplomate, American Board of Radiology
- Lipovitch, Fred B. (1970) *Medical Consultant*
 M.D., Loyola University, Stritch School of Medicine
- Palmer, Paul E., F.A.C.O.S. (1969) *Medical Consultant P/T*
 B.S., M.D., Northwestern University; Diplomate, American Board of
 Orthopedic Surgery
- Poggi, Joseph T., F.A.C.O.G. (1968) *Medical Consultant P/T*
 B.S., M.D., University of Illinois; Diplomate, American Board of
 Obstetrics and Gynecology
- Rodawig, Donald F., F.A.C.S. (1966-67; 1970) *University Physician*
 B.S., M.D., State University of Iowa
- Roth, Edward (1965) *University Physician*
 B.S., University of Pittsburgh; M.D., St. Louis University

- Scott, Woodrow S., F.A.C.S. (1964) *University Physician*
 B.S., University of Kentucky; M.D., Medical College of Virginia
- Watson, Ernest S., F.A.A.P. (1964) *University Physician*
 B.S., University of Wisconsin; M.D., University of Chicago; Diplomate,
 American Board of Pediatrics

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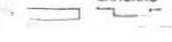
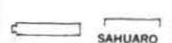
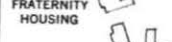
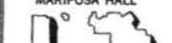
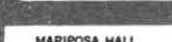
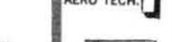
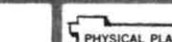
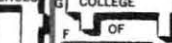
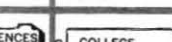
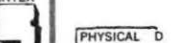
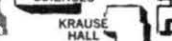
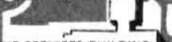
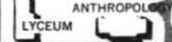
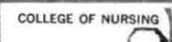
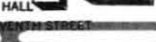
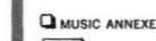
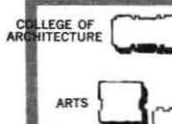
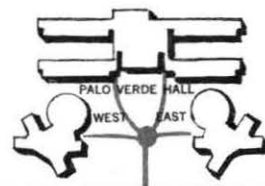
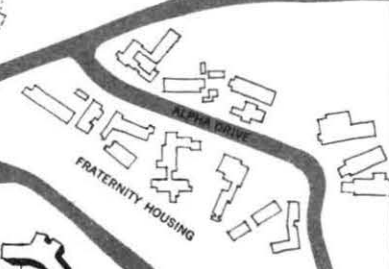
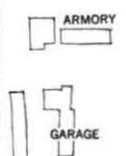
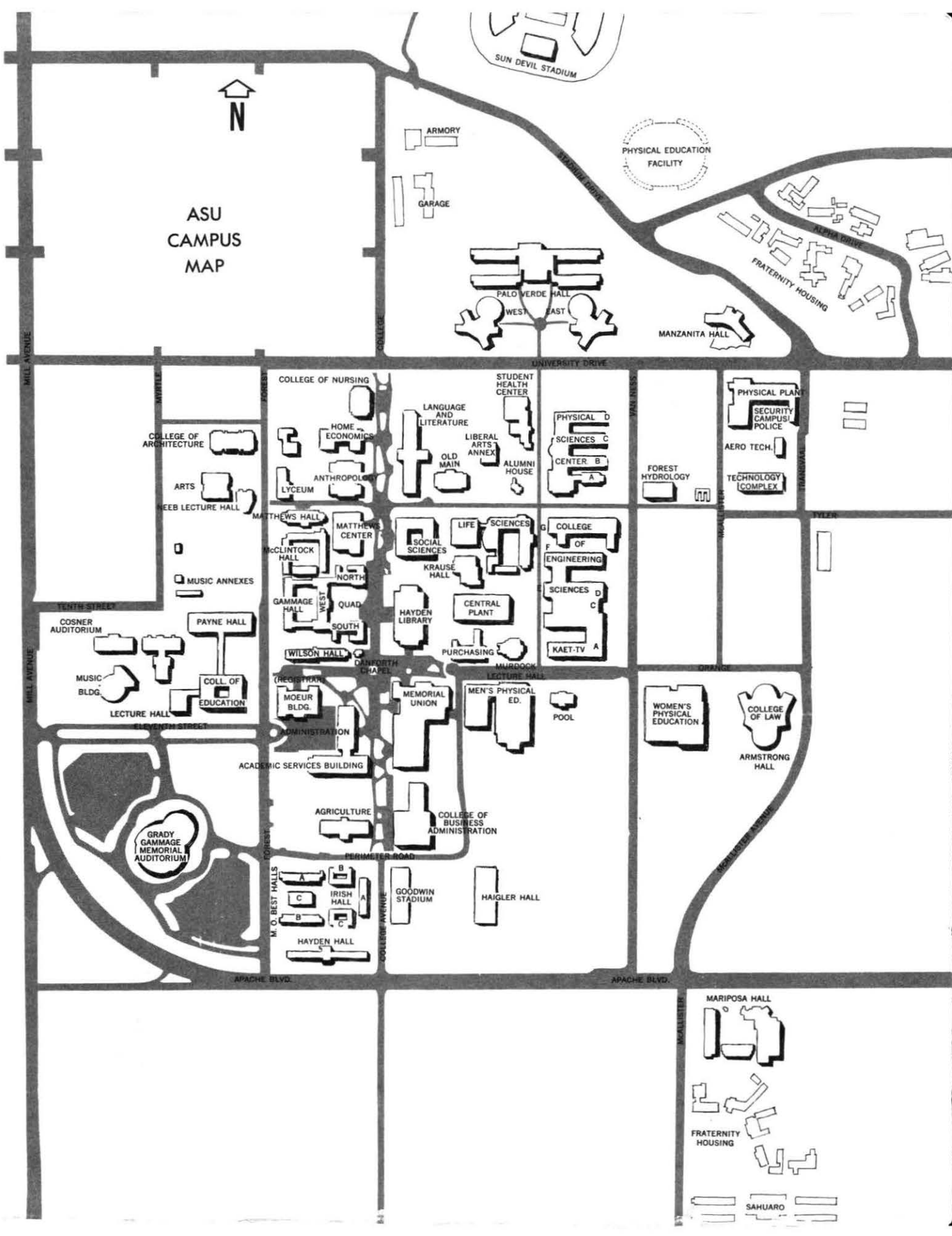
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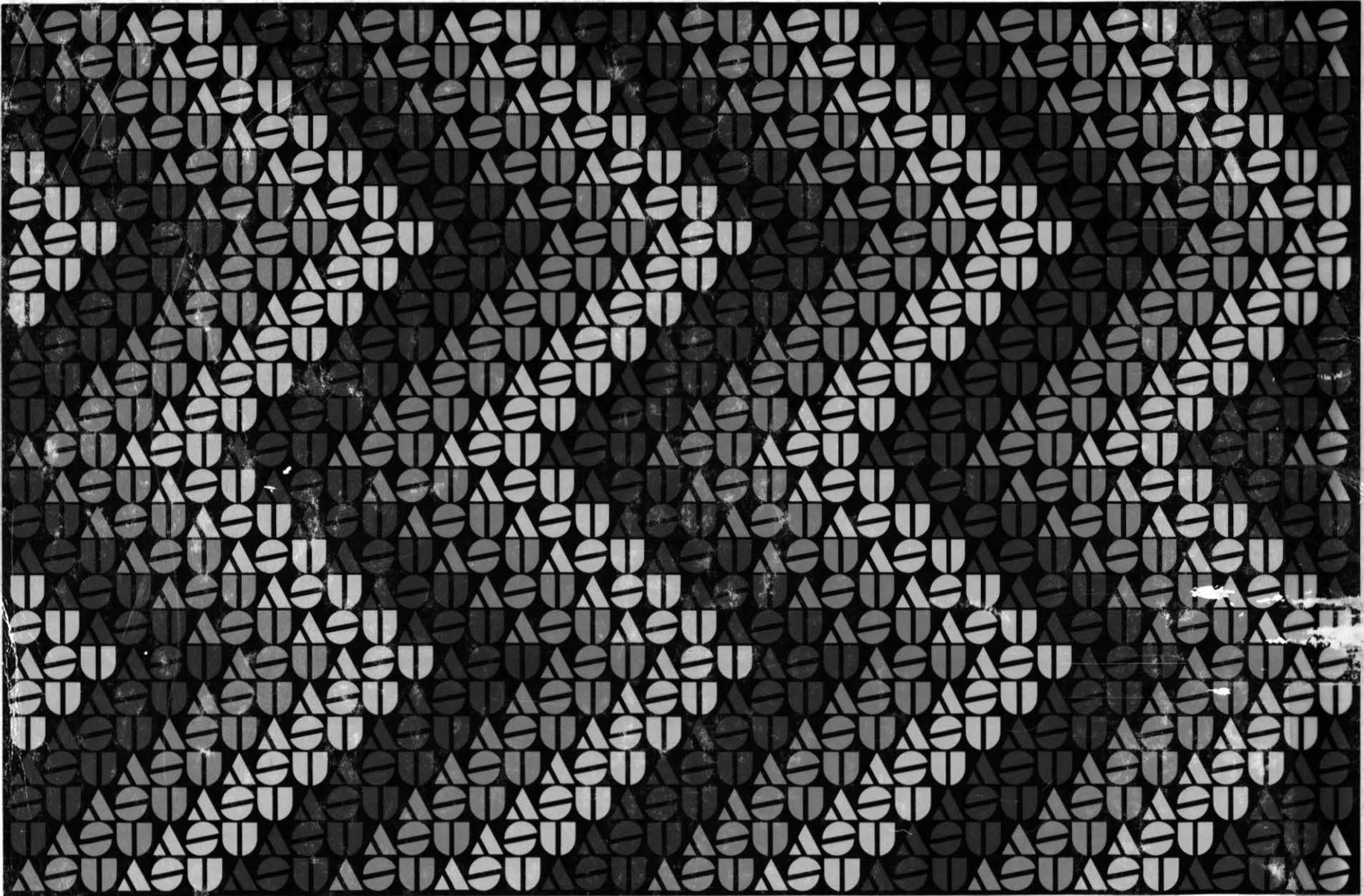
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