

Graduate Programs and Descriptions of Courses

Accountancy

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PROFESSORS

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 PHILIPPAKIS, RECKERS, RENEAU,
 SCHULTZ, SHRIVER, R. SMITH,
 STEINBART, TIDWELL, WYNDELTS

ASSOCIATE PROFESSORS

CHRISTIAN, GOLEN, GOUL, GUPTA,
 KEIM, KIANG, KULKARNI, MOECKEL,
 O'DELL, O'LEARY, PEI, REGIER,
 ROY, ST. LOUIS, VINZE

ASSISTANT PROFESSORS

CHENOWETH, DAVID, HWANG,
 MISHRA, K. SMITH, WHITECOTTON

SENIOR LECTURER

MACCRACKEN

LECTURERS

J.L. BOATSMAN, DOWLING,
 GEIGER, HALL, TAYLOR

The faculty in the School of Accountancy and Information Management, College of Business, offer specialized professional programs leading to the Master of Accountancy, Master of Science in Information Management (see pages 227–229 for more information), and Master of Taxation (see pages 61–64, and 116 for more information) degrees.

The student, in consultation with a faculty advisor, must prepare a program of study composed of common required courses, required courses for a particular area of study, and elective courses from those available which meet the candidate's specific needs.

The faculty participate in offering the program leading to the Master of Business Administration degree. See page 102 for information on the Master of Business Administration degree.

The faculty also participate in offering the program leading to the Ph.D. in Business Administration degree. See pages 143–148 for information on this degree program.

MASTER OF ACCOUNTANCY

The Master of Accountancy degree provides an opportunity for students to develop specialized knowledge in accounting information systems management (i.e., management advisory services, computer systems design and security, and EDP audit). See page 99 for information on the Master of Accountancy degree.

RESEARCH ACTIVITY

The research interests of the School of Accountancy and Information Management faculty and graduate students cover most areas of accounting, broadly defined. The following list of project areas is intended to be illustrative—but not all-inclusive—of the work being done: processing of information by decision makers at the individual and group level, behavior decision theory, information systems, modeling of internal control systems, database management systems architecture, design of computer networks, minicomputer security, analytical reviews in auditing, managerial influence on internal auditors' professional judgments, heuristics for audit sampling, adequacy of financial statement disclosures, effect of segment reporting on prediction of earnings and cash flow, financial reporting of changing prices, accounting policy formulation, real asset risk determinants of systematic risk, reporting for accounting changes, social and psychological influences related to tax, audit and general accounting issues, tax planning models, partnership taxation, tax policy and practice, microeconomic aspects of tax law changes, and behavioral research in taxation.

ACCOUNTANCY (ACC)

ACC 502 Financial Accounting. (3) A Financial accounting concepts and procedures for external reporting. Prerequisite: M.B.A. degree program student.

ACC 503 Managerial Accounting. (3) A Managerial accounting concepts and procedures for internal reporting. Prerequisite: M.B.A. degree program student.

ACC 511 Taxes and Business Strategy. (3) A Economic implications of selected management decisions involving application of federal income tax laws. Recognition of tax hazards and tax savings. Prerequisite: ACC 502 or equivalent.

ACC 515 Professional Practice Seminar. (3) A

History, structure, environment, regulation, and emerging issues of the accounting profession.

ACC 521 Tax Research. (3) A

Tax research source materials and techniques. Application to business and investment decisions. Prerequisite: ACC 430.

ACC 533 EDP Auditing. (3) N

Analysis of EDP audit techniques and evaluation methods. Emphasis on current topics such as distributed processing and microcomputers. Prerequisite: ACC 450.

ACC 541 Strategic Cost Management and Uses of Information Technology. (3) A

Strategic cost management emphasizing contemporary topics, including activity-based costing and strategic uses of information technology systems. Cooperative learning, lecture. Prerequisite: ACC 350 or 503.

ACC 567 Financial Models in Accounting Systems. (3) A

Development and application of financial models by accountants. Analysis of decision support systems as financial modeling environments. Prerequisite: ACC 330.

ACC 571 Taxation of Corporations and Shareholders. (3) A

Tax aspects of the formation, operation, reorganization, and liquidation of corporations and the impact on shareholders. Prerequisite: ACC 430.

ACC 573 Taxation of Partners and Partnerships. (3) A

Tax aspects of the definition, formation, operation, liquidation, and termination of a partnership. Tax planning is emphasized. Prerequisite: ACC 430.

ACC 575 Estate and Gift Taxation. (3) A

Tax treatment of wealth transfers at death and during life time, with emphasis on tax planning. Prerequisite: ACC 430.

ACC 577 Taxation of Real Estate Transactions. (3) A

Income tax aspects of acquisition, operation, and disposal of real estate; syndications; installment sales; exchanges; dealer-investor issues; alternative financing; and planning. Prerequisite: ACC 521 or instructor approval.

ACC 582 Auditing Theory and Practice. (3) N

Function and responsibility of the auditor in modern society. Advanced topics in auditing theory and methods. Contemporary issues in auditing. Prerequisite: ACC 450.

ACC 586 Shareholder Value Creation and Financial Statement Analysis. (3) N

Develop skills necessary to exploit financial reporting information in a business environment and appreciation of reporting issues faced by management.

ACC 587 Computerized Accounting Systems. (3) A

Design and evaluation of computer-based accounting information system. Development of computer-based financial models for planning and control. Prerequisite: ACC 330.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

Aerospace Engineering

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PROFESSORS

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WALLACE, WIE

ASSOCIATE PROFESSORS

KOURIS, MIGNOLET, RANKIN, WELLS

ASSISTANT PROFESSORS

LEE, PUIG-SUARI

The faculty in the Department of Mechanical and Aerospace Engineering offer graduate programs leading to the M.S., Master of Science in Engineering, and Ph.D. degrees in Aerospace Engineering. A number of areas of study may be pursued, including aerodynamics, design, dynamics and control, propulsion, and structures. The faculty also offer graduate degree programs in Mechanical Engineering. All of the department's graduate programs stress a sound foundation leading to a specialized area of study.

Graduate Record Examination. All applicants are required to take the Graduate Record Examination; the subject test in Engineering is highly recommended but not required.

MASTER OF SCIENCE

See pages 97–99 for information on the M.S. degree.

MASTER OF SCIENCE IN ENGINEERING

See page 114 for information on the Master of Science in Engineering degree.

DOCTOR OF PHILOSOPHY

The Ph.D. degree is conferred upon evidence of excellence in research leading to a scholarly dissertation that is an original contribution to knowledge in the field of aerospace engineering.

See pages 120–122 for general requirements.

Program of Study. The program of study must be established no later than the first semester after successfully completing the qualifying examination.

Qualifying Examinations. The purposes of the qualifying criteria are to assess if the student is prepared to continue in the doctoral program and to detect deficiencies in the student's background that can be corrected by appropriate course work and individual study. Within the first year of graduate studies at ASU, graduate students pursuing a Ph.D. in Aerospace Engineering must complete three 500-level, preferably, core courses in the major area of interest, and one 500-level mathematics course; an average GPA of 3.25 or above in this course work is required. Specific qualifying course requirements for each major area are available from the department.

Foreign Language Requirements. None.

Comprehensive Examinations. Written and oral comprehensive examinations are required. The examinations are administered by the program committee.

Dissertation Requirements. A dissertation based on original work demonstrating creativity in research and scholarly proficiency in the subject area is required.

Final Examinations. A final oral examination in defense of the dissertation is required.

RESEARCH ACTIVITY

The department has established a wide variety of theoretical and experimental research programs in Aerospace Engineering to prepare graduate students for careers with industry, universities, and government agencies. The faculty are organized into groups pursuing research topics directly related to general improvement of knowledge in engineering fields or to the application of engineering principles to problems of high national priority.

Some recent and current examples of faculty and student research projects include studies in: acoustic fatigue; aeroelasticity; aerospace vehicle dynamics,

guidance, and control; aerospace structures; aerospace vehicle design and performance optimization; aircraft crash-worthiness; applied computational methods; atmospheric dynamics and surface layers; biomechanics; boundary-layer transition; combustor modeling; composite materials; concurrent engineering; convection heat transfer in complex flows; finite element techniques; flow-induced vibrations; fracture mechanics; fluid-structure interactions; heat transfer in airbreathing and space propulsion systems; high speed aerodynamics; hydrodynamic stability; hypersonics; laminar flow control; laser diagnostics in combustion and flows; micromechanics; modal analysis; modeling and optimal design of rotor-bearing systems; noise control; nonlinear vibrations and structural dynamics; nonlinear waves and dynamics; perturbation methods; rotorcraft aerodynamics and acoustics; separated and transitional flows; spray combustion; structural optimization; supersonic flows; thermionics; three-dimensional boundary layers; transonic aerodynamics; turbulent flow modeling; turbine cooling; and unsteady aerodynamics.

Experimental investigations are carried out in a number of specialized laboratories and facilities: computer-aided engineering and expert systems laboratory; computer-aided design/computer-aided manufacturing laboratory; combustion laboratory; composite materials laboratory; direct energy conversion laboratory; dynamics and controls laboratory; heat transfer laboratory; laser diagnostics laboratory; hydrodynamic stability laboratory; stratified flow laboratory; supersonic wind tunnel laboratory; robotics laboratory; thermoscience laboratory; turbulent fluid mechanics laboratory; unsteady wind tunnel facility; and vibrations and dynamics laboratory. Equipment fabrication is supported by the college's well-equipped development shop with a staff of machinists and electronic technicians.

Computer Resources and Facilities

Aerospace Engineering graduate education and research is supported by an extensive array of college- and university-supported computer hardware and software, in addition to laboratory minicomputers and microcomputers. The ASU Computing Commons is equipped with three IBM RS/6000-

590s, one MASPAR, several DEC VAX 5000s, numerous Sun Sparc servers, and many other platforms. Access to these computers is via the ASU Advanced Communications Support System (ACSS) broadband network as well as via dial-in lines. The university also operates microcomputer sites with more than 400 IBM and Apple Macintosh systems.

MECHANICAL AND AEROSPACE ENGINEERING

The faculty in the Department of Mechanical and Aerospace Engineering offer graduate programs leading to the degrees of Master of Science, Master of Science in Engineering, and the Doctor of Philosophy with majors in Aerospace Engineering and Mechanical Engineering. The courses supporting both majors are offered under the common MAE prefix. See pages 246-248 for the courses that support the degree programs in Aerospace Engineering. Additional courses at the 300 and 400 level, which may be used to remove deficiencies, are described in the General Catalog.

Agribusiness

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PROFESSORS

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ASSOCIATE PROFESSORS
 RACCACH, SEPERICH

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 PATTERSON, RICHARDS, STANTON

MASTER OF SCIENCE

The Agribusiness faculty in the School of Agribusiness and Resource Management offer a program leading to the M.S. degree in Agribusiness. Courses are offered at the ASU East site. Concentrations are available in agribusiness management and marketing and food quality assurance. An area of study may be in resource management. This program is designed to prepare students for managerial and administrative positions in agribusiness and government. Students receive broad training in agribusiness functional areas and analytical methods. To

apply the knowledge and skills gained in course work, each student conducts a research project and writes a thesis.

Admission. Applicants to the program are expected to meet the minimum requirements for admission to the Graduate College. In addition, scores from the Graduate Record Examination, Miller Analogies Test, or Graduate Management Admission Test are recommended. Applicants are expected to have completed 18 hours of agribusiness or other closely related course work, with at least nine hours specifically in agribusiness. Applicants not meeting this last requirement may be considered for admission with deficiencies.

Program of Study. Candidates must complete a minimum of 30 semester hours of approved graduate-level course work, excluding courses taken to remove deficiencies. A minimum of 12 semester hours should consist of regularly scheduled course work within the agribusiness core, not including hours taken in research, thesis, reading and conference, special topics, or courses of a similar nature. Students must complete the following courses:

AGB 508	Advanced Agribusiness Marketing	3
	or AGB 511 Advanced Agribusiness Management II (3)	
AGB 510	Advanced Agribusiness Management I	3
AGB 525	Advanced Agribusiness Management Systems	3
AGB 527	Agribusiness Research Methods	3
AGB 532	Advanced Agribusiness Finance	3
	Research and Thesis	6
	Total	21

Other course work will be selected in order to develop an effective graduate program for each individual.

Cooperative Degree Program. The School of Agribusiness and Resource Management and the American Graduate School of International Management (Thunderbird) have a cooperative agreement for students interested in both agribusiness and international management. Thunderbird is an internationally recognized private graduate school, located in the Phoenix metropolitan area, offering course work in international studies, modern languages,

and world business. This agreement enables students of ASU to take up to nine semester hours of course work at Thunderbird. To participate, the ASU student must be enrolled full-time (nine semester hours) and may only take three semester hours per semester at Thunderbird. The goal of this agreement is to enhance the educational opportunities available to qualified students of both institutions while making optimal use of the resources and facilities of both institutions.

Foreign Language Requirements.

None.

Comprehensive Examinations. Each student must pass a written comprehensive examination covering materials presented in the Agribusiness program of study.

Thesis Requirements. All students are required to write a thesis.

Final Examinations. An oral examination in defense of the thesis is required.

RESEARCH ACTIVITY

The research projects in agribusiness reflect the varied interests of the faculty. Marketing studies involving agricultural products are conducted to determine consumer desires or the attitudes of institutional personnel toward foods. Management studies designed to improve the efficiency of agribusiness or to identify the job stress factors of the employees represent another sector. Finance studies examine the capacity of financial institutions to provide capital for agribusiness firms or the ability of managers to optimize the returns to financial resources under their control. In addition, the research conducted by the food industry faculty is directed toward the safety and wholesomeness of food, both at the institutional and consumer levels.

AGRIBUSINESS (AGB)

AGB 402 Agricultural Cooperatives. (3) N Organization, operation, and management of agricultural cooperatives.

AGB 404 Sales and Merchandising in Agribusiness. (3) SS

The principles and techniques of selling and commodity merchandising in the agricultural industries.

AGB 412 Agricultural Commodities. (3) F Trading on futures markets. Emphasis on the hedging practices with grains and meats. Prerequisite: AGB 312 or 1 marketing or finance course.

AGB 413 Agribusiness Finance II. (3) S Advanced agribusiness investment management and financial practices.

AGB 414 Advanced Commodity Trading.

(3) N

Advanced analysis of trading techniques, with emphasis on hedging in the futures markets. Prerequisite: AGB 412 or 413.

AGB 423 Food and Industrial Microbiology.

(3) N

Food- and industrial-related microorganisms; deterioration and preservation of industrial commodities. Lecture, lab. Prerequisite: MIC 205 or 206 or instructor approval.

AGB 424 Food and Industrial Fermentations. (4) N

Management, manipulation, and metabolic activities of industrial microbial cultures and their processes. Lecture, lab. Prerequisite: AGB 423 or instructor approval.

AGB 425 Food Safety. (3) N

Control, prevention, and prediction of microbial and chemical food-borne diseases. Prerequisite: AGB 423 or instructor approval.

AGB 426 Food Chemistry. (4) N

The biochemical and chemical interactions that occur in raw and processed foods. Lecture, lab. Prerequisites: CHM 115, 231.

AGB 428 Comparative Nutrition. (3) N

Effects of nutrition on animal systems and metabolic functions. Prerequisite: CHM 231.

AGB 433 Diseases of Domestic Animals.

(3) S

Control and prevention of infectious and non-infectious diseases of domestic animals. Prerequisite: MIC 206 or 220.

AGB 435 Animal Physiology I. (3) N

Control and function of the nervous, muscular, cardiovascular, respiratory, and renal systems of domestic animals. Prerequisites: BIO 181; CHM 113.

AGB 439 Veterinary Practices. (3) F, S

Observation of and participation in veterinary medicine and surgery supervised by local veterinarians. Prerequisite: advanced preveterinary student.

AGB 440 Food Marketing. (3) S

Food processing, packaging, distribution, market research, new food research and development, and social implications. Prerequisite: AGB 312.

AGB 443 Agribusiness Management II. (3)

S

Principles of human resource management, with emphasis on the special problems of agribusiness systems.

AGB 444 Agribusiness Analysis. (3) S

Analysis of agribusiness firm decisions in the ecological, economic, social, and political environments. Special emphasis on ethical issues surrounding food production and consumption. *General Studies: L2.*

AGB 450 International Agricultural Development. (3) S

Transition of developing countries from subsistence to modern agriculture. Technology transfer and food improvement programs are emphasized. *General Studies: G.*

AGB 453 World Agricultural Resources. (3)

SS

World production and consumption of agricultural products, international relationships, and agencies concerned with world agricultural development problems. *General Studies: G.*

AGB 454 International Agricultural Trade.

(3) S

Dimensions, locations, mix, methods, and changes of international trade in agricultural products. Prerequisite: AGB 312.

AGB 455 Agricultural Marketing Channels.

(3) F

Operational stages of agricultural commodities in normal distribution systems and implementation of marketing strategies. Prerequisite: AGB 312.

AGB 460 Agribusiness Management Systems. (4) S

The development and use of decision support systems for agribusiness management and marketing. Lecture, lab.

AGB 474 Agribusiness Policy and Government Regulations. (3) F

The development and implementation of government food, drug, pesticide, and farm policies and regulations that affect the management of agribusiness.

AGB 490 Recent Advances in Agribusiness. (1) F, S

Reports and discussions of current topics and problems associated with agribusiness. May be repeated for credit.

AGB 505 Commodity Analysis. (3) N

Analysis of commodity markets. Prerequisite: 1 year of economics or marketing.

AGB 508 Advanced Agribusiness Marketing. (3) F

Theory and analysis of marketing farm commodities, risks, and the effect of future trading on cash prices.

AGB 509 Advanced Agribusiness Marketing Channels. (3) S

Analysis of agribusiness market channel systems. Formulation of marketing strategies.

AGB 510 Advanced Agribusiness Management I. (3) F

Managing and financing agribusiness emphasizing environmental and economic sustainability in a global economy undergoing radical change. Prerequisite: AGB 342.

AGB 511 Advanced Agribusiness Management II. (3) S

Analysis of organization behavior, change, and resource requirements within agribusiness systems. Prerequisite: AGB 342.

AGB 512 Food Industry Management. (3) S

Operations and management of food-processing factories, food distribution centers, and retail food-handling firms.

AGB 516 International Agricultural Techniques. (3) N

Coordination of production and marketing techniques to consumption objectives with agricultural products in foreign countries.

AGB 518 World Agricultural Development.

(3) N

Factors that influence production, processing, and marketing of agricultural products in developing countries.

AGB 520 Advanced Agribusiness Analysis I. (4) S

Vertical integration and differentiation in food and agricultural industries. Lecture, recitation. Prerequisite: AGB 508 or 510.

AGB 521 Agribusiness Coordination. (4) N

Organizational alternatives for agribusiness, with emphasis on cooperatives and trading companies. Lecture, recitation. Prerequisite: AGB 508 or 510.

AGB 525 Advanced Agribusiness Management Systems. (3) N

Development and use of decision support systems for agribusiness management decision making. Prerequisite: AGB 510.

AGB 527 Agribusiness Research Methods. (3) N

The use of model building, hypothesis testing, and empirical analysis in solving agribusiness problems. Prerequisite: basic statistics course.

AGB 530 Advanced Agribusiness Policy. (3) N

Policy-making history, structure, and process. Prerequisite: AGB 342.

AGB 532 Advanced Agribusiness Finance. (3) F

Financial management of agribusiness firms; agribusiness financial analysis, investment analysis, agricultural risk management, and introduction to agricultural financial intermediaries. Prerequisites: computer literacy and 1 finance course *or* instructor approval.

AGB 535 Advanced Food Science. (3) N

Chemical and physical nature of processed foods. Emphasis on food product development. Prerequisite: AGB 364.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

Anthropology

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REGENTS' PROFESSOR
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PROFESSORS

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CHANCE, CLARK, COWGILL, EDER,
HUDAK, JOHANSON, KINTIGH,
KOSS-CHIOINO, MARTIN, MERBS,
NASH, REDMAN, SCHOENWETTER,
STARK, WILLIAMS

ASSOCIATE PROFESSORS

AGUILAR, ALVAREZ, BARTON,
FALCONER, HEDLUND, HEGMON,
KIMBEL, MARZKE, B. NELSON,
M. NELSON, RICE, SPIELMANN

ASSISTANT PROFESSORS

REED, STEADMAN, WELSH

SENIOR LECTURER

WINKELMAN

The faculty in the Department of Anthropology offer graduate programs leading to the M.A. and Ph.D. degrees in Anthropology.

Admission. In addition to the general requirements for admission to the Graduate College, the Department of Anthropology requires applicants to provide a statement of their interests and professional goals, and three letters of recommendation. Applicants who received their B.A. during the past ten years must also submit scores on the Graduate Record Examination. Undergraduate course work in anthropology is not a prerequisite for admission to the M.A. program. Admission to the Ph.D. program normally presumes an M.A. in Anthropology; students may be admitted without such a background on the condition that they acquire a knowledge of general anthropology in a manner to be specified at the time of admission.

Program of Study. Special training programs designed to terminate with a master's degree are possible at the discretion of the student and faculty advisors. For example, the concentrations in linguistics, museum studies, medical anthropology, and bioarchaeology are at the master's level. The primary purpose and scope of the graduate program in anthropology, however, is intended to lead to the Ph.D. degree.

The doctoral program is divided into three phases. The first consists of 24 semester hours of course work and readings, usually within a subdiscipline and closely allied areas, followed by six semester hours for the M.A. thesis (or publishable paper). The faculty may require additional hours of course work or other preparation for entering students who are unfamiliar with the concepts of general anthropology at a level equivalent to that of the Arizona State undergraduate anthropology core. Mastery of the phase I course material is demonstrated by successful completion of a written qualifying examination in social-cultural anthropology or, in physical anthropology, bioarchaeology, and archaeology, by successful completion of a sequence of core courses.

Admission to phase II of the doctoral program is granted to students on the basis of performance in phase I, the quality of M.A. research, prior course work, faculty recommendations, and other relevant information. The second phase consists of 30 semester hours of course work, reading in anthropology and related fields, and directed research designed to prepare the student for the

dissertation project. Proficiency in one foreign language or quantitative methods may be required by the supervisory committee. The second phase is completed when the following have been met: (1) passing a written comprehensive examination, and (2) passing the oral defense of the dissertation proposal. The successful student is then advanced to candidacy.

The final phase consists of 24 semester hours of research and dissertation.

Certificate in Museum Studies. The certificate is awarded to nondegree or graduate students who are accepted into the certificate program and who complete 12 hours of required course work and a six-semester hour internship at an approved museum. The certificate may be taken independently or in conjunction with the M.A. degree in Anthropology with a concentration in museum studies.

Master of Public Health. The faculty in the department participate in offering a Master of Public Health (M.P.H.) with a concentration in cultural and behavioral dimensions of public health as a part of the Arizona Graduate Program in Public Health on the University of Arizona campus. This program concentration offers theoretical and practical learning experiences to enable the student to develop competencies in understanding and planning health programs for culturally diverse clients and communities in the United States and across the world. The central objective of the concentration is understanding and evaluating cultural influences on health and illness, health promotion, and disease prevention.

MASTER OF ARTS

Concentrations are available at the master's level in archaeology, bioarchaeology, linguistics, medical anthropology, museum studies, physical anthropology, and social-cultural anthropology.

The new medical anthropology concentration emphasizes biocultural perspectives on the study of health and illness behavior. The faculty has a range of teaching and research activities that span biological, physical, ecological, sociocultural, and applied areas of medical anthropology. The program combines theoretical approaches with an applied problem-solving focus to

prepare students for careers both in academia and in health care delivery and public health.

See pages 97–99 for information on the M.A. degree.

CONCURRENT M.A. ANTHROPOLOGY AND M.S. JUSTICE STUDIES

Graduate students in the Department of Anthropology and the School of Justice Studies are able to receive a concurrent M.A. in Anthropology with a concentration in social-cultural anthropology and a M.S. degree in Justice Studies. The principal purpose of the program is to prepare individuals with complementary knowledge and skills for basic and applied research, in addition to administrative and educational activities related to justice studies and anthropology.

Students must be admitted separately to each program, following the guidelines of the Graduate College, Department of Anthropology, and School of Justice Studies. Additional information on the M.A. in Anthropology and the M.S. in Justice Studies may be obtained from each academic unit.

DOCTOR OF PHILOSOPHY

Concentrations are available at the doctoral level in archaeology, physical anthropology, and social-cultural anthropology.

See pages 120–122 for more information on the Ph.D. degree.

RESEARCH AND TEACHING ACTIVITIES

Faculty in the Department of Anthropology are actively engaged in research on a wide range of problems and in a variety of geographical settings, with special strength in the American Southwest, Southeast Asia, Mesoamerica, the Near East, and the Arctic. Individual faculty conduct research in Arizona, New Mexico, Ohio, Alaska, Canada, Guatemala, Mexico, England, Spain, Jordan, Morocco, Kenya, Madagascar, New Guinea, Thailand, Indonesia, and the Philippines.

While most research and teaching center on problems associated with one of the traditional subfields of anthropology, many departmental programs include faculty from various branches of anthropology. Research and teaching in archaeology center on archaeo-

logical theory, research methods, quantitative methods, computer and statistical applications, paleoecology of hunter-gatherers, and the archaeology of social complexity. The program in social-cultural anthropology emphasizes social organization, religion, ecology and demography, research methods, human biology and social behavior, and anthropological linguistics. The physical anthropology program stresses osteology, dental anthropology, primatology, functional morphology, growth and development, paleoanthropology, human biological variation, disease ecology, and human origins. The program in museum studies includes emphases in curation, exhibition, educational programming, and administration. The medical anthropology program emphasizes biocultural perspectives on the study of health and illness behavior. The bioarchaeology program applies a holistic, ecological perspective in considering biological, environmental, demographic, and cultural processes at regional and local scales. The program in linguistics is interdisciplinary and has strengths in American Indian and Southeast Asian languages, bilingualism, language renewal, language and education, and ethnopoetics.

Among the research resources of the department are large archaeological, ethnographic, dental, and osteological collections; a majority of available fossil hominid casts; numerous archaeology and physical anthropology laboratories; departmental computers; radiographic, serologic, and pollen facilities; ethnographic and linguistic archives. The department publishes a monograph series, *Anthropological Research Papers*, and two series of field reports, *Anthropological Field Studies* and *OCRM Reports*. The department also maintains the Office of Cultural Resource Management and the Arizona State University Museum of Anthropology. The department operates the Deer Valley Rock Art Center in north Phoenix, a research and interpretive center situated at the largest concentration of petroglyphs in the Phoenix area. The Museum of Anthropology, which is housed in the Anthropology Building, works closely with the Heard Museum of Native American Cultures and Art, the Desert Botanical Gardens, the Pueblo Grande Museum, the Tempe Historical Society, and other museums in the area.

ANTHROPOLOGY (ASB)

ASB 400 Cultural Factors in International Business. (3) S

Anthropological perspectives on international business relations; applied principles of cross-cultural communication and management; regional approaches to culture and business. Cross-listed as IBS 400. *General Studies: G.*

ASB 411 Kinship and Social Organization. (3) S

Meanings and uses of concepts referring to kinship, consanguinity, affinity, descent, alliance, and residence in the context of a survey of the varieties of social groups, marriage, rules, and kinship terminological systems. Prerequisite: 6 hours of anthropology or instructor approval.

ASB 412 History of Anthropology. (3) F Historical treatment of the development of the culture concept and its expression in the chief theoretical trends in anthropology between 1860 and 1950. Prerequisite: ASB 102 or instructor approval. *General Studies: L2/SB.*

ASB 416 Economic Anthropology. (3) F Economic behavior and the economy in preindustrial societies; description and classification of exchange systems; relations between production, exchange systems, and other societal subsystems. Prerequisite: ASB 102 or instructor approval. *General Studies: L2/SB.*

ASB 417 Political Anthropology. (3) A Comparative examination of the forms and processes of political organization and activity in primitive, peasant, and complex societies. Prerequisite: ASB 102 or instructor approval.

ASB 462 Medical Anthropology: Culture and Health. (3) F 1998

Role of culture in health, illness, and curing; health status, provider relations, and indigenous healing practices in United States ethnic groups. Lecture, discussion. *General Studies: C.*

ASB 471 Introduction to Museums. (3) F History, philosophy, and current status of museums. Exploration of collecting, preservation, exhibition, education, and research activities in different types of museums. Prerequisites: ASB 102 and ASM 101 or instructor approval. *General Studies: L2.*

ASB 480 Introduction to Linguistics. (3) F Descriptive and historical linguistics. Survey of theories of human language, emphasizing synchronic linguistics. *General Studies: SB.*

ASB 481 Language and Culture. (3) S Application of linguistic theories and findings to nonlinguistic aspects of culture; language change; psycholinguistics. Prerequisite: ASB 102 or instructor approval. *General Studies: SB.*

ASB 483 Sociolinguistics and the Ethnography of Communication. (3) N

Relationships between linguistic and social categories; functional analysis of language use, maintenance, and diversity; interaction between verbal and nonverbal communication. Prerequisites: ASB 480 and ENG 213 (or FLA 400) or instructor approval. *General Studies: SB.*

ASB 501 Applied Medical Anthropology. (3) F

Overview of anthropology's applications in medicine and its adaptations to U.S. ethnic populations. Requires research project in medical setting. Lecture, seminar. Prerequisite: graduate standing or instructor approval.

ASB 502 Health of Ethnic Minorities. (3) S
Prevalence of illness, risk factors, health ecology, and medical and indigenous treatments. Lecture, seminar. Prerequisite: graduate standing or instructor approval.

ASB 503 Advanced Medical Anthropology. (3) F
Theory in Medical Anthropology and cross-cultural studies that illustrate particular theories. Lecture, seminar. Prerequisite: graduate standing or instructor approval.

ASB 504 Ethnic Relations. (3) F
Structural processes of intergroup relations, methods for investigating psychocultural dimensions of ethnicity with focus upon U.S. ethnic groups. Lecture, seminar. Prerequisite: graduate standing or instructor approval.

ASB 505 Culture and Psychiatry. (3) F
Psychiatry as a cultural phenomenon and indigenous definitions and treatments of mental disorders across cultures. Lecture, seminar. Prerequisite: graduate standing or instructor approval.

ASB 506 Gender, Emotions, and Culture. (3) S
Relationships among gender and emotion across cultures. Lecture, seminar. Prerequisite: graduate standing or instructor approval.

ASB 529 Culture and Political Economy. (3) N
Origin and spread of Western capitalism and its impact on non-Western societies. Ethnographic and historical case studies are utilized. Prerequisite: graduate standing.

ASB 530 Ecological Anthropology. (3) A
Relations among the population dynamics, social organization, culture, and environment of human populations, with special emphasis on hunter-gatherers and extensive agriculturalists.

ASB 532 Graduate Field Anthropology. (2–8) S
Independent research on a specific anthropological problem to be selected by the student in consultation with the staff. May be repeated for credit. Prerequisites: ASM 338 or equivalent; instructor approval.

ASB 536 Ethnohistory of Mesoamerica. (3) N
Indigenous societies of southern Mexico and Guatemala at Spanish contact and their post-conquest transformation. Emphasis is on the Aztec Empire. Prerequisite: graduate standing.

ASB 537 Topics in Mesoamerican Archaeology. (3) N
Changing organization of pre-Columbian civilizations in Mesoamerica is explored through interpretive issues, such as regional analysis, chiefdoms, urbanism, and exchange. Prerequisite: instructor approval.

ASB 540 Method and Theory of Sociocultural Anthropology and Archaeology I. (3) F
Basic issues concerning concepts of social and ethnic groups, cultural and sociological theory, and the nature of anthropological research. Prerequisite: instructor approval.

ASB 541 Method and Theory of Social and Cultural Anthropology. (3) S
Continuation of ASB 540. Prerequisite: ASB 540 or instructor approval.

ASB 542 Method and Theory of Archaeology II. (3) S
Models of human evolution, culture change, and interpretation of hunter-gatherer and tribal societies, ceramic, lithic, and faunal materials. Prerequisite: instructor approval.

ASB 543 Method and Theory of Archaeology III. (3) F
Covers concepts of social complexity along with economy, demography, and social dynamics, followed by archaeological research design. Prerequisite: instructor approval.

ASB 544 Settlement Patterns. (3) N
Spatial arrangement of residences, activity sites, and communities over landscape. Emphasis on natural and cultural factors influencing settlement patterns. Prerequisite: instructor approval.

ASB 546 Pleistocene Prehistory. (3) F
Development of society and culture in the Old World during the Pleistocene epoch, emphasizing technological change through time and the relationship of people to their environment. Prerequisite: ASB 361 or equivalent.

ASB 547 Issues in Old World Domestication Economies. (3) S
Archaeological evidence for transitions in Old World subsistence economies from hunting and gathering to dependence on domesticated plants and animals. Prerequisite: ASB 362 or equivalent.

ASB 550 Economic Archaeology. (3) N
Prehistoric economies in hunter-gatherer, tribal, and complex societies. Subsistence strategies, craft production and specialization, and exchange covered. Prerequisite: instructor approval.

ASB 551 Prehistoric Diet. (3) N
Includes (1) a critical review of techniques for recovering dietary information and (2) theoretical models concerned with explaining diet and nutrition. Prerequisite: instructor approval.

ASB 555 Complex Societies. (3) S
Structural variations in hierarchically organized societies, along with origins, dynamics, and collapse, are examined. Seminar.

ASB 559 Archaeology and the Ideational Realm. (3) N
“Post-processual” and other views concerning relevance of mental phenomena for understanding sociocultural change. Various approaches to inferring prehistoric meanings.

ASB 563 Hunter-Gatherer Adaptations. (3) N
Evolution of prehistoric hunter-gatherer societies in the Old and New Worlds from the most ancient times through protohistoric chiefdoms. Prerequisite: instructor approval.

ASB 567 Southwestern Archaeology. (3) S
Broad coverage of Southwestern cultural developments focusing on current debates and rigorous use of archaeological data in making cultural inferences.

ASB 568 Intrasite Research Strategies. (3) F
Research issues within a single site context. Topics include quantitative spatial analysis, site definition, sampling, distributional analysis, and substantive interpretation.

ASB 571 Museum Principles. (3) F
History, philosophy, and current status of museums. Exploration of collecting, preservation, exhibition, education, and research activities in different types of museums. Prerequisites: ASB 102 and ASM 101 or instructor approval.

ASB 572 Museum Collection Management. (3) S
Principles and practices of acquisition, documentation, care, and use of museum collections; registration, cataloging, and preservation methods; legal and ethical issues. Prerequisite: ASB 571 or instructor approval.

ASB 573 Museum Administration. (3) S
Formal organization and management of museums; governance; personnel matters; fund raising and grantsmanship; legal and ethical issues. Prerequisite: ASB 571 or instructor approval.

ASB 574 Exhibition Planning and Design. (3) S
Exhibition philosophies and development; processes of planning, designing, staging, installing, evaluating, and disassembling temporary and long-term exhibits. Prerequisites: ASB 571 and 572 or instructor approval.

ASB 575 Computers and Museums. (3) F
Basics of museum computer application; hardware and software; fundamentals of database management; issues of research, collections management, and administration.

ASB 576 Museum Interpretation. (3) F
Processes of planning, implementing, documenting, and evaluating educational programs in museums for varied audiences—children, adults, and special interest groups. Lecture, discussion. Prerequisite: ASB 571.

ASB 577 Principles of Conservation. (3) S
Preservation of museum objects: nature of materials, environmental controls, and causes of degradation; recognizing problems, damage, and solutions; proper care of objects. Prerequisites: ASB 571 and 572 or instructor approval.

ASB 579 Critical Issues in Museum Studies. (3) F
Current debates of museum practice from an anthropological perspective. Issues of collection, presentation, authenticity, and authority are addressed. Seminar. Prerequisite: ASB 571 or instructor approval.

ASB 591 Seminar. (3) N
Selected topics in archaeology, linguistics, and social-cultural anthropology.
(a) Archaeological Ceramics
(b) Archaeology of North America
(c) Cultural Anthropology
(d) Culture and Personality
(e) Evolution and Culture
Cross-listed as ASM 591.
(f) Historical Archaeology
(g) Interdepartmental Seminar
Cross-listed as ASM 591.
(h) Linguistics
(i) Museum Studies
(j) Problems in Southwestern Archaeology
(k) Problems in Southwestern Ethnology
(l) Social Anthropology

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

ANTHROPOLOGY (ASM)

ASM 435 Archaeological Pollen Analysis. (3) F
Theory, methodology, and practice of pollen analytic techniques. Compares uses in botany, geology, and archaeology. 2 hours lecture, 3 hours lab, possible field trips. Prerequisite: instructor approval.

ASM 452 Dental Anthropology. (4) F
Human and primate dental morphology, growth, evolution, and genetics. Within- and between-group variation. Dental pathology and behavioral-cultural-dietary factors. 3 hours lecture, 3 hours lab. Prerequisite: instructor approval. *General Studies: S2.*

ASM 454 Comparative Primate Anatomy. (4) S
Functional anatomy of the cranial, dental, and locomotor apparatus of primates, including humans, emphasizing the relation of morphology to behavior and environment. 3 hours lecture, 3 hours lab, dissections, demonstrations. Prerequisite: instructor approval.

ASM 455 Primate Behavior Laboratory. (3) N
Instruction and practice in methods of observation and analysis of primate behavior. Discussion of the relationship between class work on captive animals and field techniques for studying free-ranging groups. Directed readings, 6 hours lab. Prerequisites: ASM 343; instructor approval. *General Studies: L2.*

ASM 465 Quantification and Analysis for Anthropologists. (3) S
Statistical, quantitative, and geometric strategies for envisioning and exploring archaeological, physical anthropological, bioarchaeological, and sociocultural data. Univariate and multivariate methods. Prerequisites: introductory statistical course; instructor approval.

ASM 507 Anthropological Study of Disease. (3) A
In-depth introduction to the study of disease processes from an anthropological perspective. Lecture, seminar. Prerequisite: graduate standing or instructor approval.

ASM 548 Geoarchaeology. (3) F
Geologic context relevant to archaeological research. Topics include sediments, deposition environments, soils, anthropogenic and biogenic deposits, and quaternary chronology. Prerequisite: instructor approval.

ASM 555 Advanced Human Osteology. (3) N
Laboratory and field techniques in dealing with the human skeleton. Emphasis on preparation, identification, radiography, sectioning, microscopy, and data processing. 1 hour lecture, 6 hours lab. Prerequisite: ASM 341 or instructor approval.

ASM 565 Quantitative Archaeology. (3) S
Formal methods of structuring, codifying, and analyzing data for archaeological problems. Designing research to yield data amenable to productive analysis.

ASM 566 Advanced Topics in Quantitative Archaeology. (3) F
Archaeological issues associated with quantitative analysis, e.g., Bayesian and Monte Carlo approaches, simulation, diversity. May be repeated for credit. Prerequisite: ASM 565 or instructor approval.

ASM 573 Lithic Analysis. (3) N
Analysis and interpretation of chipped stone artifacts. Focus on both techniques and underlying concepts and their application to real collections. Prerequisite: instructor approval.

ASM 591 Seminar. (3) N
Selected topics in archaeology and physical anthropology.

- (a) Bioarchaeology
- (b) Evolution and Culture
Cross-listed as ASB 591.
- (c) Interdepartmental Seminar
Cross-listed as ASB 591.
- (d) Physical Anthropology
- (e) Primates and Behavior

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

Architecture

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REGENTS' PROFESSOR COOK

PROFESSORS

BOYLE, EL DIASTY, McCOY,
McSHEFFREY, MEUNIER,
PETERSON, RAPP,
SCHEATZLE, UNDERHILL

ASSOCIATE PROFESSORS

HARTMAN, KUPPER, LOOPE,
McINTOSH, OZEL, SHEYDAYI,
UNDERWOOD, ZYGAS

ASSISTANT PROFESSORS

ELLIN, KROLOFF,
SOROKA, VAN DUZER

RESEARCH PROFESSOR JONES

The faculty in the School of Architecture offer a professional program leading to the Master of Architecture degree.

The faculty in the school also offer a research-based graduate program leading to the M.S. degree in Building Design. See pages 143–144 for information on this degree program.

The faculty in the school also participate in offering a Ph.D. in Environmental Design and Planning. See pages 199–200 for information on this degree program.

MASTER OF ARCHITECTURE

See pages 99–102 for information on this degree program.

RESEARCH ACTIVITY

Faculty and students in the graduate programs of the School of Architecture are involved in the following areas of research: energy-conscious design, computer graphics, housing, urban design, building technology, environmental analysis, arid region design, and architectural history and theory.

The School of Architecture maintains laboratories for solar, structural, and materials testing, including a 1,500-square-foot rooftop testing laboratory for solar research.

Facilities for basic research activities and community service oriented programs in energy technology, design, real estate development, and planning are also provided by the College of Architecture and Environmental Design through the Herberger Center for Design Excellence and the joint urban design program.

Architecture

Courses offered by the faculty of the School of Architecture are categorized in the instructional areas described on this page.

Architectural Administration and Management (AAD). AAD courses investigate the organization and managerial aspects of contemporary architectural practice. These studies examine the overall processes relative to management coordination, administration procedures, ethics, legal constraints, and the financial controls and measures of contemporary architectural practice.

Architectural Design and Technology Studios (ADE). ADE encourage synthesis of the knowledge and understanding the student has gained from previous and parallel course work, and from other sources, toward the comprehensive design of architectural projects. The laboratories integrate the needs, limitations, and determinants of design problems while applying analytical methods and technical skills in seeking and comparing alternative solutions for assigned problems.

Architectural Philosophy and History (APH). APH develops an understanding of architecture as both a determinant and a consequence of man's

culture, technology, human needs, and behavior in the past and present. These studies are concerned with the rationale for the methods and results of design and construction.

Architectural Technology (ATE). ATE develops knowledge of the technical determinants, resources, and processes of architecture. These studies are concerned primarily with the science and technology of design and construction, including materials, structural systems, construction systems, environmental control systems, active and passive solar systems, acoustics and lighting.

Architecture Professional Studies (ARP). ARP provides students with residency and off-campus opportunities and educational experience in group and individual studies relative to specific student interests and faculty expertise.

The program also offers several opportunities to study abroad. In addition, various required and optional field trips are undertaken in course work. (Supplemental fees are assessed for these offerings.)

Environmental Analysis and Programming (ANP). ANP develops capabilities to analyze and program environmental and human factors as preconditions for architectural design. These studies are concerned with the existing and emerging methods used by the profession to evaluate and analyze. A variety of courses on computer utilization is included in this area.

ARCHITECTURAL ADMINISTRATION AND MANAGEMENT (AAD)

AAD 551 Architectural Management I. (3) S Organizational, human performance, and market influences on architecture firms and projects. Readings, case studies, and analysis of managerial problems and solutions. Lecture, discussion. Prerequisite: graduate-level standing. Corequisite: ADE 522.

AAD 552 Architectural Management II. (3) F Design delivery, coordination of construction documents, cost estimating, bidding and negotiations, construction observation, and post-construction services. Case studies. Lecture, discussion. Prerequisite: AAD 551. Corequisite: ADE 621.

AAD 553 Advanced Architectural Management. (3) A Current issues in the business and practice of architecture. Financial management, project management, and design delivery strategies. Includes case studies. Lecture, discussion. Prerequisite: AAD 551 or instructor approval.

AAD 554 Advanced Construction Contract Administration. (3) N Advanced topics and problems in construction contract administration. Prerequisite: AAD 552 or instructor approval.

AAD 555 Architect as Developer. (3) A Development building, real estate, construction funding, land acquisition, and the sources for capital. Prerequisite: instructor approval.

AAD 558 Advanced Specifications and Cost Analysis. (3) N Coordination of working drawings, construction specifications, and cost estimates. Emphasis on methods, office procedures, contract conditions, bonds, and bidding procedures. Prerequisite: instructor approval.

AAD 560 Contemporary Architectural Practice. (3) A Advanced issues and directions in design delivery, firm and project management, global markets and expanding cultural responsibilities. Includes case studies. Seminar. Prerequisite: instructor approval.

AAD 681 Professional Seminar: Capstone. (3) S Examination of ethical, political, social, economic, ecological, and cultural issues confronting the practice of architecture. Readings and case studies. Seminar. Prerequisite: AAD 552. Corequisite: ADE 622.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

ARCHITECTURAL DESIGN AND TECHNOLOGY STUDIOS (ADE)

ADE 510 Foundation Architectural Studio. (6) SS Fundamentals of architectural design, methodology, visualization, and representation. Lecture, studio, field trips. Prerequisite: admission to graduate program.

ADE 511 Core Architectural Studio I. (6) F Application of design fundamentals in architectural problems, including construction, technology, programmatic and environmental determinants. Lecture, studio, field trips. Prerequisites: ADE 510; APH 200, 509. Corequisite: ATE 353.

ADE 512 Core Architectural Studio II. (6) S Application of architectural design fundamentals to increasingly complex problems, including specific sites and activities. Lecture, studio, field trips. Prerequisite: ADE 511.

ADE 521 Advanced Architectural Studio I. (5) F Design problems emphasizing theory, aesthetics, and tectonics as influences on architectural form. Lecture, studio, field trips. Prerequisite: admission to graduate program.

ADE 522 Advanced Architectural Studio II. (5) S Design problems emphasizing the comprehensive integration of building systems and technologies as influences on architectural form. Lecture, studio, field trips. Corequisites: AAD 551; ADE 521.

ADE 621 Advanced Architectural Studio III. (5) F Design problems emphasizing the urban context, planning issues, and urban design theory as influences on architectural form. Lecture, studio, field trips. Corequisites: AAD 552; ADE 522; instructor approval.

ADE 622 Advanced Architectural Studio IV. (5) S Individual, student-initiated project reflecting a culminating synthesis of architectural ideas. Studio. Prerequisites: ADE 621; ANP 681. Corequisite: AAD 681.

ADE 661 Bioclimatic Design Studio. (6) A Sustainable architectural and site synthesis at a variety of scales emphasizing bioclimatic criteria and the use of passive and low-energy systems. Prerequisite: professional degree or instructor approval. Corequisite: ATE 558.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

ENVIRONMENTAL ANALYSIS AND PROGRAMMING (ANP)

ANP 530 Computer Graphics in Architecture. (3) A Fundamentals of computer graphics programming in architecture, including graphics hardware, device independent packages, 2- and 3-dimensional transformations, and data structures. 2 hours lecture, 3 hours lab. Prerequisite: ANP 475 or instructor approval.

ANP 561 Architectural Information Processing Systems. (3) A Applications of information processing systems to architectural problems. Analysis of computing tools with respect to assumptions and theories. Lecture, lab. Prerequisites: graduate standing; instructor approval.

ANP 562 Information Systems for Facilities Management. (3) N Introduction to database design and implementation. Assessment of facility management problems from information system points of view. Seminar, lab. Prerequisites: ANP 477 or (561); graduate standing.

ANP 576 Community Housing. (3) N History, practices, trends, and forms of housing; includes growth of public programs, national and local programs, zoning law, housing distribution, planning principles and policies, design review, standards, and private development practice.

ANP 577 Housing Environments. (3) A Contemporary housing environments, housing types, and life styles as determined by user preference, density, development and property standards, cost, community and privacy, security, identity, movement, and the need for open space.

ANP 581 Urban Structure and Design. (3) F The nature and dynamics of urbanization and its relationship to architecture and urban design, including growth, decay, socialization, planning processes, and visual perception. Case studies. Prerequisite: professional-level standing.

ANP 681 Project Development. (3) F 1998 Definition and elaboration of major ideas for implementation in ADE 622 Advanced Architectural Studio IV in relation to contemporary theory and practice. Seminar. Prerequisite: ADE 522.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

ARCHITECTURAL PHILOSOPHY AND HISTORY (APH)

APH 509 Foundation Seminar. (3) SS Historical, technical, theoretical, environmental, and professional issues in architecture. Lecture, seminar, field trips. Prerequisite: ADE 510.

APH 511 Energy Environment Theory. (3) F Solar and other energy sources in designed and natural environments; architectural, urban, and regional implications of strategies using other renewable resources.

APH 681 Architectural Theory. (3) S An examination of architectural theory. Emphasis on application of theory to practice. Seminar. Prerequisite: instructor approval.

APH 682 Architectural Criticism. (3) F An examination of architectural criticism, emphasizing specific methods of criticism and their application for aesthetic judgment. Seminar. Prerequisite: instructor approval.

APH 683 Critical Regionalism. (3) N Critical inquiry in cultural grounding the definition of place in architectural theory and practice. Lecture, field studies. Prerequisite: APH 446 or 447.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

ARCHITECTURAL TECHNOLOGY (ATE)

ATE 501 Introduction to Solar Energy. (3) N Introduction to theoretical and practical aspects of use of solar radiation and nocturnal cooling for control of building environments.

ATE 521 Building Environmental Science. (3) F Scientific principles relating to comfort and environmental control. Heat and moisture transfer. Solar/natural energies for heating, cooling, and lighting. Lecture, lab. Prerequisite: MAT 290 or equivalent.

ATE 522 Desert Habitation Technology. (3) N Analysis of habitation approaches in nontechnological and technological societies arising from the nature of desert areas.

ATE 530 Daylighting Design. (3) S Daylight analysis, availability, design sky measurements, modeling and simulation. Integration with passive heating, cooling, building design, and energy considerations. Lecture, lab.

ATE 533 Building Performance Simulation and Visualization. (3) S Simulating, analyzing, and evaluating building energy, lighting, and acoustic systems using computer software packages. Lecture, lab.

ATE 534 Earth Sheltering. (3) S Fundamentals of earth-atmosphere interaction, thermal and moisture effects, soil appraisal, underground passive techniques, comfort and energy efficiency. Lecture, lab.

ATE 550 Passive Cooling in Buildings. (3) N Theory, analysis, and application of passive and low energy cooling systems for thermal comfort in buildings. Prerequisite: ATE 521.

ATE 551 Passive Heating in Buildings. (3) N Theory, analysis, and application of passive and low energy heating systems for thermal comfort in buildings. Prerequisite: ATE 521.

ATE 552 Energy Parameters in Buildings. (3) N

Advanced modeling. Transient and multidimensional analysis of thermal and daylight performance using variable weather data. Prerequisite: ATE 551 or instructor approval.

ATE 553 Building Systems III. (3) F Design and integration of building systems, including mechanical, electrical, plumbing, security, communications, fire protection, and transportation. Prerequisite: admission to upper division or instructor approval.

ATE 554 Building Energy Efficiency. (3) S Impact of building design on energy performance. Climate responsiveness, operations dynamics, and subsystems integration in thermal comfort and efficiency. Prerequisite: ATE 452.

ATE 557 Construction Documents I. (3) S Production of architectural working drawings; legal status, organization, layout, site survey plans, sections, elevations, details, schedules, and coordination. Lecture, lab. Prerequisite: admission to upper division.

ATE 558 Bioclimatic Parameters. (3) S Theory, analysis, and application of energy-related parameters of site, climate, human comfort, and building program for design synthesis.

ATE 560 Building Energy Analysis. (3) F Computer simulation of building thermal behavior. Software review. Detailed study of selected simulation models using case study projects. Lab. Prerequisites: ANP 475 (or 477); ATE 582.

ATE 561 Energy Analysis Techniques. (3) F Mathematical models of building envelope and comfort conditioning systems as bases for optimization techniques. Prerequisite: ATE 560.

ATE 562 Experimental Evaluation. (3) A Instrumentation, measurement and computational techniques for analysis of building components, and assessment of thermal and luminous performance. Prerequisite: ATE 521.

ATE 563 Building Structures III. (3) F Analysis, design, and detailing of steel buildings and frames. Lateral analysis of small rigid and braced frame systems. Lecture, lab. Prerequisite: ATE 462 or equivalent.

ATE 564 Advanced Structures: Concrete. (3) A Analysis, design, and detailing of concrete systems, considering continuity, multistory frames and shear walls, and lateral analysis. Computer application. Prerequisite: ATE 563 or instructor approval.

ATE 565 Advanced Structures: High Rise. (3) A Developments in high-rise construction. Effects of wind and seismic forces. Preliminary analysis, design, and detailing considering code requirements. Lecture, lab. Prerequisite: ATE 563 or instructor approval.

ATE 582 Environmental Control Systems. (3) A Heating, ventilation, and air-conditioning systems. Loads, psychrometrics, refrigeration cycle, air/water distribution, controls, energy performance standards, and utility rates. 2 hours lecture, 3 hours lab, field trips. Prerequisite: ATE 451 or 521.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

ARCHITECTURE PROFESSIONAL STUDIES (ARP)

ARP 684 Professional Internship. (2–6) S Field experience in an architectural firm specializing in an area directly related to the student's advanced study. Integration of theory and state-of-the-art practices. Credit/no credit. Prerequisite: instructor approval.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

Art

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SCHMIDT, SHARER, STULER,
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MAXWELL, PATEL, PITTSLEY,
SANFT, SCHLEIF, SCHOEBEL,
SCHUTTE, SERWINT, STOKROCKI,
UMBERGER, VERSTEGEN

ASSISTANT PROFESSORS

PESSLER, WOLFTHAL

The faculty in the School of Art offer a program with a major in Art leading to the M.A. degree with concentrations in art education and art history.

The faculty also offer a program with a major in Art leading to the Master of Fine Arts degree. See pages 105–108 for information on the M.F.A. degree.

Students admitted to the Master of Education degree program with a major in Secondary Education may also elect art as the subject matter field.

A Doctor of Education degree program option, with a concentration in art education, is available. The Ed.D. is offered and administered through the College of Education. See pages 118–119 for program description.

MASTER OF ARTS

Art Education

Admission. An applicant must have a bachelor's degree from an accredited college or university with a major of not less than 45 semester hours of art, including 12 hours of art history and six hours of art education. Additional hours may be required by the school.

An applicant must have a GPA of at least 3.00 in undergraduate course work during the junior and senior years. Applicants who do not meet these requirements must submit scores from the Miller Analogies Test or the Graduate Record Examination. Applicants should submit a formal art education research paper for review.

Program of Study. The degree program requires a minimum of 30 semester hours of credit in art education, including 18 hours of core courses, six hours of special topics on research related to integrating the teaching of studio art, art history, and criticism or aesthetics, and six hours of research and thesis.

To meet the core requirements, students must take the following core courses:

ARE 510	Art Education Colloquium	3
ARE 520	Issues in Teaching Art History	3
ARE 525	Research on Teaching Art History	3
ARE 530	Issues in Teaching Studio Art	3
ARE 535	Research on Teaching Studio Art	3
ARE 540	Teaching Art in Cultural Contexts	3

Before the end of the first semester of course work (six or more semester hours), a program of study must be submitted to the Graduate College. Additional program requirements are indicated in the *Guidelines for the M.A. in Art Education*.

Qualifying Research Paper. A qualifying research paper must be submitted at the end of the semester in which the student completes the first 15 hours of course work. This paper must be judged satisfactory by the art education faculty before the start of the following semester, or the student is put on probation. During the semester following the qualifying research paper review, the student on probation may not enroll in

more than nine semester hours of course work (these may not be thesis hours). To continue in the program, the student must submit a satisfactory research paper before the end of that semester.

Thesis Requirements. A written thesis is required.

Final Examinations. A final oral examination in defense of the thesis is required.

Art History

Admission. An applicant must have a bachelor's degree with an undergraduate major or minor in art history, or at least four upper-division art history courses, in which an average GPA of 3.00 was maintained. Graduate Record Examination (aptitude test) scores must be submitted in support of the application, along with three letters of recommendation. Applicants should submit one formal research paper for review and a one-page statement of intent indicating their objectives for graduate study. The application deadline is February 1.

Program of Study. The degree program requires 33 semester hours of credit including a minimum of 21 hours in art history, with at least 12 of these earned in 500-level seminars. At least one course must be taken in each of the four core areas: non-western, ancient/medieval, renaissance/baroque, and modern. Satisfactory completion of ARS 500 Research Methods is required during the first semester of residence. The remaining hours include ARS 599 Thesis, approved electives, and other courses specified by the faculty.

For more information, a student should request a copy of the *Procedural Guidelines for the M.A. Program in Art History* from the School of Art.

Foreign Language Requirements.

Demonstration of a reading knowledge of one foreign language (French, German, or with faculty approval, another language appropriate to the field of study) is required. Depending upon the student's chosen area of study, reading knowledge of an additional language may be required.

Qualifying Research Paper. In order for the student to continue graduate study, a qualifying research paper, sub-

mitted in the semester in which 15 hours will be completed, must be judged satisfactory by the faculty.

Thesis Requirements. A written thesis is required.

Final Examinations. A final oral examination in defense of the thesis is required.

MASTER OF FINE ARTS

Art

The Master of Fine Arts degree in Art requires a minimum of 60 semester hours of graduate work beyond the bachelor's degree. The objective of this degree is to provide advanced study in one or more of the following concentrations: ceramics, drawing, fibers, intermedia, metals, painting, photographic studies, photography, printmaking, sculpture, or wood. See pages 105–108 for information on this degree program.

RESEARCH ACTIVITY

Faculty and student research is conducted in the following areas:

Art History. American art, Chinese art, art criticism, history of photography, Native American art, pre-Columbian art, ancient, medieval, renaissance, baroque, modern art, and critical theory.

Art Education. Teaching and learning in studio art and art history with an emphasis on elementary, secondary, and higher education settings; multicultural and cross-cultural art; curriculum and instruction; development of instructional resources (e.g., video and computer instruction); developmental studies; assessment in art; theoretical issues; historical, philosophical, and qualitative/quantitative research in art education.

Studio Art. Painting and drawing, intermedia, fine art printing and bookmaking, papermaking, sculpture, lithography, screenprinting, intaglio and monoprinting, computer graphics, video art, fine art photography, ceramics, metalworking, wood, and fibers. Studio faculty and graduate students pursue ongoing research in various materials and techniques and investigate images and concepts in contemporary and historical art forms.

Resources for studio art research include the Visual Arts Research Studios, which incorporate the Print Research

Facility, the Photography Collaboration Facility, and the Pyracantha Press (typography and limited edition books).

Research activities are enhanced greatly by active programs utilizing visiting artists/scholars, guest lecturers, and by the resources of the ASU Art Museum and Hayden Library, the Phoenix Art Museum, and the Heard Museum of Native American Cultures and Art.

ART AUXILIARY (ARA)

ARA 460 Gallery Exhibitions. (3) F, S Practical experience in all phases of department gallery operations and preparation of gallery publications. May be repeated for credit. Prerequisite: instructor approval.

ARA 488 Understanding Art. (3) F, S Understanding art as an emergent cultural phenomenon with an emphasis on a critical examination of conceptual issues in art. Writing required. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: L2/HU.*

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

ART EDUCATION (ARE)

ARE 450 Studio Art: Art History I. (3) A Art traditions before the 20th century as a basis for studio and art history instruction. 2 hours lecture, 2 hours studio. Pre- or corequisite: ARE 460.

ARE 460 Disciplines of Art Education. (3) A Explorations in art education's disciplines, history, and people's artmaking development at diverse age levels and abilities. Lecture, discussion. Prerequisites: ARS 101 and 102 and ART 113 and 115 or instructor approval.

ARE 470 Art Criticism: Aesthetics. (3) F Traditions of aesthetics and art criticism; conceptual issues in contemporary art; education in the visual arts. 2 hours lecture, 2 hours studio. Prerequisite: ARE 460 or instructor approval.

ARE 482 Studio Art: Art History II. (3) S Art traditions of the 20th century as a basis for studio and art history instruction. 2 hours lecture, 2 hours studio. Must be taken before enrollment in ARE 486. Students are recommended to take ARE 470 concurrently. Prerequisite: ARE 450.

ARE 486 Art Education: Strategies and Applications. (3) F The implementation and evaluation of art instruction for K–12 population. Includes teaching of Saturday classes in the Children's Art Workshop. Prerequisite: ARE 482.

ARE 496 Methods and Assessment of Learning in Art. (3) S Individual or group research on the assessment of art learning incorporating theory and practice. Prerequisites: ARE 470 and 486 or instructor approval.

ARE 510 Art Education Colloquium. (3) F Historical foundations of art education and faculty presentation of positions regarding teaching and research related to the visual arts. Must be taken in the first 6 hours of study.

ARE 520 Issues in Teaching Art History. (3) A Critical examination of issues concerning teaching art history to different populations of students. Historical and philosophical foundations and emphasis on developing inquiry into historical and cultural contexts of art. Recommended to be taken before ARE 525.

ARE 525 Research on Teaching Art History. (3) A Review of empirical and historical research, research methods, learning theory, and assessment of learning in art history. Pilot studies on the effects of instruction upon learning. Recommended to be taken after ARE 520.

ARE 530 Issues in Teaching Studio Art. (3) A Critical examination of issues concerning teaching multicultural art to different populations of students. Historical and philosophical foundations reviewed. Recommended to be taken before ARE 535. Lecture, discussion.

ARE 535 Research on Teaching Studio Art. (3) A Review of empirical and historical research methods, learning theory, and assessment of learning in studio art, including developmental studies and their limitations. Pilot studies on the effects of instruction upon learning. Recommended to be taken after ARE 530.

ARE 540 Teaching Art in Cultural Contexts. (3) A Relationship of multicultural perspectives to teaching/learning art criticism, aesthetics, studio art, and art history.

ARE 610 Issues and Trends in Art Education. (3) N Doctoral-level investigation of historical and contemporary issues related to teaching and research in art education.

ARE 611 Curriculum Development in Art Education. (3) N Doctoral-level inquiry into the philosophical, psychological, and sociological foundations of curriculum development.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

ART HISTORY (ARS)

ARS 400 History of Printmaking. (3) A History of the print as an art form and its relation to other modes and forms of artistic expression. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU, H.*

ARS 410 Early Christian and Byzantine Art. (3) A Art and architecture of the early church and the Byzantine Empire from the 4th to the 15th century. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU.*

ARS 412 Early Medieval Art. (3) N Painting, sculpture, architecture, and the minor arts from Migration, Carolingian, and Ottonian periods considered within religious, social, and economic contexts. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU, H.*

ARS 417 Late Gothic Art in Central Europe. (3) N Sculpture, painting, and architecture of the late-Gothic style (ca. 1350–1525), considered within religious, social, economic, and political contexts. Prerequisites: ARS 101 and 102 or instructor approval.

ARS 418 Renaissance Art in Northern Europe. (3) A Graphics, painting, sculpture, and architecture ca. 1450–1550. Reformation themes and Renaissance style considered within religious, political, social, and economic contexts. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU.*

ARS 420 Early Renaissance Art in Italy. (3) N Painting, sculpture, and architecture in Italy from 1300 to 1500. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU, H.*

ARS 424 Italian Baroque Art. (3) A Italian painting, sculpture, and architecture of the 17th century. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU, H.*

ARS 426 Art of the 17th Century in Northern Europe. (3) A Baroque painting, sculpture, and architecture in Flanders, the Netherlands, France, and England. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU, H.*

ARS 434 From Courbet to Cézanne: History of European Art 1860–WWI. (3) S Aesthetic, political, and social forces affecting the visual arts in the late 19th century. Concentration on Cubism, Expressionism, Impressionism, and Post-Impressionism. Cross-listed as HUM 494. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU.*

ARS 436 Art at the Turn-of-the-Century: 1885–1914. (3) F History of European avant-garde movements. Concentration on post-impressionism, symbolism, expressionism, and cubism. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU.*

ARS 438 Art of the 20th Century I. (3) A Developments and directions in art between 1900 and World War II. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU, H.*

ARS 439 Art of the 20th Century II. (3) A Art since World War II, with consideration of new concepts and experimentation with media and modes of presentation. Prerequisites: ARS 101 and 102 and 438 or instructor approval. *General Studies: HU, H.*

ARS 453 Issues in Contemporary Photography. (3) A A discussion seminar identifying, defining, and researching the issues and ideas that influence the appearance and criticism of contemporary images. Seminars, lectures, presentations, papers. Prerequisites: ARS 350, 351.

ARS 454 Research and Writing in Photography. (3) A Principles and practice of research and writing in the history and criticism of photography. Papers required. Prerequisites: ARS 450 and 451 or instructor approval; ENG 101 and 102 or equivalents.

ARS 457 History of Art Criticism. (3) N Theories of criticism of the visual arts from late 18th century to present. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: H.*

ARS 458 Critical Theories in the Visual Arts. (3) N

Examines current critical theories through their application to all visual arts. May include new historicism, Marxism, deconstruction, post-structuralism, semiotics, Lacanian psychoanalysis, feminism, postmodernism. Lecture, discussion, student presentations. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU.*

ARS 459 Writing Art Criticism. (3) N

Traditional and contemporary approaches to the criticism of art. Students will write critical essays. The latter half of the semester will stress the criticism of contemporary art in various media. Prerequisite: ARS 458 or instructor approval.

ARS 463 Precolumbian Art II. (3) A

Architecture, sculpture, ceramics, textiles, and other art of South America before European contact with focus on the Central Andes. Satisfies non-Western art history requirement. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU, H.*

ARS 466 Native American Art of the Southwest. (3) A

American Indian art in the southwestern states from its origins to the present day. Meets non-Western art history requirement. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU, C, H.*

ARS 468 Art of the Arctic and Northwest Coast. (3) N

Art associated with ceremony, shamanism, and daily life in the Arctic and on the Northwest Coast. Meets non-Western art history requirement. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU.*

ARS 469 Mexican Art. (3) A

Art of Mexico and related Central American cultures from the prehistoric to the contemporary schools. Meets non-Western art history requirement. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU, H.*

ARS 472 Art of China. (3) A

Study of major forms in Chinese art: ritual bronze, sculpture, ceramic, calligraphy, painting, and architecture. Satisfies non-Western art history requirement. Prerequisites: ARS 101 and 102 or instructor approval. *General Studies: HU.*

ARS 485 Women in the Visual Arts. (3) S

Historical study of art by women in various media; related social, political, educational issues; representation of women in art. Lecture, discussion. Prerequisite: ARS 101 or 102 or instructor approval. *General Studies: L2.*

ARS 501 Methodologies and Art History. (3) F

The history of the discipline and an exploration of various methodologies, critical theory, and bibliographies used by art historians. Seminar.

ARS 502 Critical Studies in Egyptian Art. (3) N

Egyptian art from pre-Dynastic to New Kingdom periods. Focus on aesthetic, philosophical, and cultural context. Research paper and readings required.

ARS 504 Critical Approaches to Greek Art. (3) A

Art and architecture of Aegean civilizations (Cycladic, Minoan, Mycenaean) and of Greece to end of Hellenistic period. Research paper and readings required.

ARS 506 Critical Studies in Roman Art. (3) A

Art and architecture of Etruria, the Roman Republic, and the Roman Empire. Research paper and/or supplemental readings required.

ARS 514 Critical Approaches to Romanesque Art. (3) N

Sculpture, painting, architecture, and the minor arts in western Europe, ca. 1030–1200, considered within religious, economic, and social contexts. Research paper required.

ARS 516 Critical Approaches to Gothic Art. (3) N

Architecture, sculpture, painting, and the minor arts in western Europe, ca. 1150–1350, considered within religious, social, and economic contexts. Research paper required.

ARS 517 Critical Approaches to Late Gothic Art. (3) N

Art of the late-Gothic style (ca. 1350–1525) considered within religious, social, economic, and political contexts. Research or reading project required.

ARS 522 Sixteenth Century Italian Art. (3) A

Critical study of painting, sculpture, and architecture in 16th century Italy in its religious and historical context.

ARS 528 Eighteenth Century Art in Europe. (3) A

Critical study of European art from the late Baroque to the early years of Neoclassicism.

ARS 530 Art of Spain and New Spain. (3) A

Critical study of architecture, painting, and sculpture from 1500 to 1800. Lecture, conference.

ARS 532 Art, Politics, and Patronage 1770–1850. (3) F

Critical analyses of political events in Europe. Issues of patronage, art as propaganda examined. Impact of war and revolution on visual arts.

ARS 534 Studies in Modern European Art, 1850–1914. (3) A

Critical study of visual arts using primary source material from mid-19th century to WWI within philosophical, socio/economic contexts. Lecture, tutorial. Prerequisite: instructor approval.

ARS 542 Critical Issues in American Painting I. (3) A

Explores themes and social issues in American art with a critical study of American painting from the 18th century to 1850. Lecture, discussion. Prerequisites: ARS 101, 102.

ARS 543 Critical Issues in American Painting II. (3) A

Explores themes and social issues in American art with a critical study of American painting from 1850 to 1900. Lecture, lab. Prerequisite: instructor approval.

ARS 544 American Modernism and Realism, 1900–1945. (3) A

Critical study of the social, political, and artistic changes in American art during the first half of the twentieth century. Prerequisites: ARS 101 and 102 or 340.

ARS 562 Art of Ancient Mesoamerica. (3) F

Critical study of art and architecture of Mexico and Maya area before Spanish contact. Lecture, conference.

ARS 565 Native Art of North America. (3) A

A critical examination of Native American art within culture, prehistory to the present. Prerequisites: ARS 101 and 102 or instructor approval.

ARS 574 Studies in Japanese Art. (3) A

A critical examination of the nature and history of Japanese art, its rich heritage and its indebtedness to foreign sources. Lecture, discussion. Prerequisites: ARS 101 and 102 or instructor approval.

ARS 575 Approaches to Chinese Painting. (3) F

A critical history of Chinese painting from Eastern Chou to 1911. Emphasis on masters, regional developments, and conceptual underpinnings. Lecture, discussion. Prerequisites: ARS 101 and 102 or instructor approval.

ARS 591 Seminar. (3–6) A

Graduate seminar in topics selected from the following. Problems or criticism in:

- American Art
- American Indian Art
- Ancient Art
- Baroque Art
- Chinese Art
- Medieval Art
- Modern Art
- Photographic History
- Pre-Columbian Art
- Renaissance Art

Prerequisite: instructor approval.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

ART**ART 401 Nonsilver Photography.** (3) F, S

Recognition of the inherent characteristics of nonsilver processes and their use in communicating ideas. 6 hours a week. May be repeated for credit. Prerequisite: ART 304 or instructor approval.

ART 403 Senior Photographic Projects. (3) F, S

Technical and philosophical refinement of personal aesthetic with various photographic media. 6 hours a week. May be repeated for credit. Prerequisite: ART 304 or instructor approval.

ART 404 Portraiture Photography. (3) F, S

Photographing people. Critical discussions and slide lectures on issues in portraiture. 6 hours a week. May be repeated for credit. Prerequisite: ART 304 or instructor approval.

ART 405 Advanced Color Photography. (3) F, S

Intensive use of subtractive color process in photographic printing. 6 hours a week. May be repeated for credit. Prerequisite: ART 305 or instructor approval.

ART 406 Photo Techniques. (3) F, S

Camera and darkroom techniques with emphasis on creative control of the black and white print. 6 hours a week. Prerequisite: ART 301 or instructor approval.

ART 407 View Camera. (3) F, S

View camera and darkroom techniques. Studio, lab. Prerequisite: ART 301 or instructor approval.

ART 408 Digital Photographic Images. (3) F, S

Scanning, manipulation, refinement, and compositing of photographic images in the computer. Lab, studio. Prerequisite: ART 201.

ART 409 Photographic Exhibition. (3) A Care of photographic prints, print presentation, and exhibition. Practical experience in gallery operations. 6 hours a week. May be repeated for credit. Prerequisite: ART 304 or instructor approval.

ART 411 Advanced Drawing. (3) F, S Visual and intellectual concepts through problem solving and independent study. Emphasis on the individual creative statement. 6 hours a week. May be repeated for credit. Prerequisites: ART 311; instructor approval.

ART 414 Advanced Life Drawing. (3) F, S Various media and techniques on an advanced level. The human figure as an expressive vehicle in various contexts. 6 hours a week. May be repeated for credit. Prerequisite: ART 315 or instructor approval.

ART 415 Art Anatomy. (4) N Study of human anatomical structures as applied to the practice of figure oriented art. 3 hours lecture, 5 hours studio a week. Prerequisite: ART 214.

ART 423 Advanced Painting. (3) F, S Continuation of ART 324. 6 hours a week. May be repeated for credit. Prerequisite: ART 324.

ART 425 Advanced Figure Painting. (3) F, S Continuation of ART 325. 6 hours a week. May be repeated for credit. Prerequisites: ART 315, 324, 325.

ART 427 Advanced Watercolor. (3) F, S Continuation of ART 327. More advanced formal, conceptual, and technical problems in contemporary watercolor. 6 hours a week. May be repeated for credit. Prerequisite: ART 327.

ART 431 Special Problems in Sculpture. (3) F, S Development of a personal approach to sculpture, emphasis on form, individual problems, and related color technology. Professional practices and presentation. 6 hours a week. May be repeated for credit. Prerequisites: ART 332; instructor approval.

ART 432 Neon Sculpture. (3) F Techniques for creating neon in an art context. Glass tube bending and fabrication. Construction of artworks utilizing light generating gases. 6 hours a week. May be repeated for credit. Prerequisite: instructor approval.

ART 436 Architectural Sculpture. (3) N Sculptural concepts as related to architecture and other man-made environments. Scale drawing, models, and relief sculpture. 6 hours a week. May be repeated for credit. Prerequisite: ART 332 or instructor approval.

ART 437 Film Animation. (3) F Production of short 16mm films that feature articulated sculptural objects, models, dolls, puppets, and graphics through the use of single frame filming techniques. 6 hours a week. May be repeated for credit. Prerequisite: instructor approval.

ART 438 Experimental Systems in Sculpture. (3) S Simple electrical and mechanical systems that can be utilized in the context of studio art and installations. Active production of studio art works required. 6 hours a week. May be repeated for credit. Prerequisite: instructor approval.

ART 439 Mixed Media. (3) F, S Exploring visual effects by combining traditional and nontraditional methods, techniques, and concepts. 6 hours a week. May be repeated for credit. Studio. Prerequisites: ART 113 and 115 and 6 hours additional studio requirements or instructor approval.

ART 440 New Media Concepts. (3) F, S Continued experiments with new media and interdisciplinary concerns in art. 6 hours a week. May be repeated for credit. Prerequisite: ART 340. Corequisite: ART 441.

ART 441 Video Art. (1) F, S Utilizing video and audio equipment essential to the production of broadcast quality video art. 2 hours a week. May be repeated for credit. Corequisite: ART 440.

ART 442 Folk/Outsider Art. (3) F Exploration of ideas, attitudes, and art of contemporary "self-taught," "visionary," and "outsider" artists. Research and studio practice. Lecture, studio. Prerequisite: ART 115 or instructor approval.

ART 443 Intermedia. (3) F, S Experimental, conceptual, and interdisciplinary studio art with emphasis on new media and technologies. 6 hours a week. May be repeated once for credit. Prerequisite: ART 340 or instructor approval.

ART 446 Computer Art II. (3) A Three-dimensional modeling, lighting, surface attributes, and special effects for art applications. Emphasis on explicit commands. Studio. Prerequisite: ART 444 or instructor approval. *General Studies: N3.*

ART 449 Computer Animation II. (3) F, S Advanced principles and applications of 3D animation for art and design. Emphasis on lighting, surfaces, and camera motion. Studio. Prerequisite: ART 448 or instructor approval.

ART 450 Computer Animation III. (3) F, S Special effects using 2D and 3D static and time-based imagery for the creation of illusions related to an artistic theme. Studio. Prerequisite: ART 449 or instructor approval.

ART 452 Advanced Lithography. (3) F, S Continuation of ART 352. 6 hours a week. May be repeated for credit. Prerequisite: instructor approval.

ART 454 Advanced Screen Printing. (3) A Continuation of ART 354. 6 hours a week. May be repeated for credit. Prerequisite: instructor approval.

ART 455 Advanced Photo Processes for Printmaking. (3) A A continued study of photomechanical techniques and applications to printmaking or photographic processes. Prerequisite: ART 355 or instructor approval.

ART 456 Fine Printing and Bookmaking I. (3) A Letterpress printing and typography as fine art. Study of history, alphabets, mechanics of hand typesetting, presswork, and various forms of printed matter. Prerequisite: instructor approval.

ART 457 Fine Printing and Bookmaking II. (3) A Continuation of ART 456. Bookbinding, book design and printing, advanced typography, theory, and presswork. May be repeated for credit. Prerequisites: ART 456; instructor approval.

ART 458 Papermaking. (3) F, S History, theory, demonstrations, sheet forming, collage treatments, and 3-dimensional approaches. 6 hours a week. May be repeated for credit. Prerequisite: instructor approval.

ART 459 Monoprinting. (3) F, S The nonmultiple printed image using a variety of technical approaches. 6 hours a week. May be repeated for credit. Prerequisites: ART 311, 323 (or any 300-level printmaking class); instructor approval.

ART 460 Ceramic Clay. (3) S Research into various clay body formulations, local natural materials, slip glazes, and engobes. Lecture, lab, studio. Prerequisites: ART 360 and 364 or instructor approval.

ART 463 Ceramic Glaze. (3) F Glaze calculation and formulation using various glaze colors and surfaces. Lecture, lab, studio. Prerequisite: ART 460 or instructor approval.

ART 466 Special Problems in Ceramics. (3) F, S, SS Emphasis on personal expression within structure of seminars, critiques, and studio work. Professional methods of presentation/documentation of work. 6 hours a week. May be repeated for credit. Prerequisite: ART 364 or instructor approval.

ART 472 Advanced Jewelry. (3) F, S Jewelry making with emphasis on developing personal statements and craftsmanship. 6 hours a week. May be repeated for credit. Prerequisites: ART 372; instructor approval.

ART 473 Advanced Metalworking. (3) A Forging and forming techniques in individualized directions. 6 hours a week. May be repeated for credit. Prerequisites: ART 373; instructor approval.

ART 474 Advanced Wood. (3) F, S Extended experience and advanced techniques in the use of wood to create functional works of art. 6 hours a week. May be repeated for credit. Prerequisites: ART 374; instructor approval.

ART 476 Fibers: Multiple Harness Weaving. (3) F, S Advanced loom techniques and computer pattern design. Emphasis on individual design and loom application. Prerequisite: ART 113 or 115 or 376 or instructor approval.

ART 477 Printed Textiles. (3) A Techniques for screen printing on fabric exploring pattern as a compositional element. Various stencil methods including photographic processes. Studio. May be repeated for credit. Prerequisite: ART 377 or instructor approval.

ART 530 Two-Dimensional and Three-Dimensional Computer Art. (3) A Integration of 2D and 3D computer imaging for art. Emphasis upon new directions for computer imaging which accounts for media characteristics. Studio.

ART 540 Advanced Computer Art. (3) A Study of motion for 3D models, light sources, and surface effects. Course assumes students have a comprehension of complex modeling, mapping, and lighting. Studio. Prerequisite: ART 446 or instructor approval.

ART 551 Intaglio Projects. (3) F, S

The materials and methods of Intaglio as a matrix for exploring various contemporary issues. Specifically structured to accommodate the graduate level drawing with no print-making background. Studio.

ART 621 Studio Problems. (3) F, S, SS

Advanced study in the following areas:

- (a) Ceramics
- (b) Drawing
- (c) Fiber Art
- (d) Metals
- (e) Painting
- (f) Photography
- (g) Printmaking
- (h) Sculpture
- (i) Studio Art
- (j) Wood

6 hours a week each section. May be repeated for credit. Prerequisite: instructor approval.

ART 680 Practicum: M.F.A. Exhibition. (1–15) F, S, SS

Studio work in preparation for required M.F.A. exhibition. Public exhibit to be approved by the student's supervisory committee and accompanied by a final oral examination. Photographic documentation and written statement of problem. Prerequisite: approval of the student's supervisory committee.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

Bioengineering

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Chair

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PROFESSORS
GUILBEAU, TOWE

ASSOCIATE PROFESSORS
GARCIA, HE, PIZZICONI,
SWEENEY, YAMAGUCHI

ASSISTANT PROFESSOR
KIPKE

The Bioengineering faculty within the Department of Chemical, Bio, and Materials Engineering offer graduate programs leading to the M.S. and Ph.D. degrees in Bioengineering. Areas of study include biochemical engineering, bioelectrical engineering, biomechanical engineering, biosystems/biotransport engineering, bioinstrumentation, biomaterial engineering, and biocontrol engineering. Research topics include artificial organs, biocontrol systems, biomechanics, bioinstrumentation, biomaterials, biosystems engineering, bio-

technology, cardiovascular engineering, cellular and tissue bioengineering, neural bioengineering, noninvasive imaging, and rehabilitation engineering.

Graduate Record Examination.

Graduate Record Examination scores are required from all students.

Transition Program. Students applying to the Bioengineering M.S. or Ph.D. degree programs may have an undergraduate B.S. degree in a major field other than Bioengineering. The qualifications of transition students are reviewed by the department graduate committee and a special program of transition course work is designed for successful applicants. In general, transition students should have had, or be prepared to take, calculus through ordinary differential equations, physics, inorganic chemistry, and a number of undergraduate engineering courses in order to be prepared for graduate Bioengineering courses. Other course work from the undergraduate program may be required depending upon the research topic selected by the student. Transition students should contact the graduate coordinator to evaluate the undergraduate transcript.

MASTER OF SCIENCE

See pages 97–99 for information on the Master of Science degree.

Program of Study. All candidates pursuing a M.S. degree in Bioengineering are required to complete an approved program of study consisting of the minimum required semester hours, including research and thesis. Special course requirements for the different areas of study are established by the faculty and are available from the Department of Chemical, Bio, and Materials Engineering. Part-time students must successfully complete a research seminar course for at least three semesters during the course of study. Candidates whose undergraduate degree was in a field other than bioengineering may be required to complete more than 30 semester hours of credit on the program of study.

Research Seminar Requirements. In addition to the course work and thesis requirements, all full-time master's degree students must successfully complete a research seminar course during each semester of attendance.

Thesis Requirements. A written thesis is required.

Final Examinations. A final oral examination in defense of the thesis is required.

DOCTOR OF PHILOSOPHY

The Ph.D. degree in Bioengineering is conferred upon evidence of excellence in research resulting in a scholarly dissertation that is a contribution to knowledge.

See pages 120–122 for general requirements.

Program of Study. Upon admission of the applicant with regular or provisional status, a supervisory committee (program committee) is appointed. This committee is responsible for the guidance and direction of the student's graduate program of study. The program committee is composed of a minimum of three faculty members, including a chair. Generally, the student's graduate advisor serves as chair of the program committee. The program committee advises the student in developing a program of study and assumes primary responsibility in assessing the student's progress in the program.

Research Seminar Requirements. In addition to the course work and dissertation requirements, all full-time doctoral students must successfully complete a research seminar course during each semester of attendance.

Qualifying Examination. A qualifying exam is administered to test the student's mastery of basic engineering fundamentals. The examination is usually taken early in the student's program of study (after two semesters of residence at ASU, and no later than three semesters). A student must express in writing the intention to take the exam to the department graduate committee through the graduate coordinator.

Foreign Language Requirements. None.

Comprehensive Examinations. When the Ph.D. student has essentially completed the course work in the approved program of study, the student is given a written comprehensive examination covering the field of study. The written

examination is followed by an oral examination.

Admission to Candidacy and Appointment of Dissertation Committee. After the student passes the comprehensive examinations, a dissertation committee composed of at least five faculty members is appointed. The dissertation committee meets to approve the student's dissertation prospectus. Generally, the prospectus should include a pertinent review of the literature, a statement of the proposed study, the hypothesis to be tested, a description of the research design, a discussion of the specific data to be collected, and a description of the means by which the data is to be analyzed. After the dissertation committee has approved the prospectus, the student applies to the Graduate College for admission to candidacy.

Dissertation Requirements. A dissertation based on original work demonstrating creativity in research and scholarly proficiency in the subject area is required. The dissertation is expected to reflect and contribute significantly to knowledge. It must clearly indicate mastery of research methods.

Final Examinations. A final oral examination in defense of the dissertation is required.

RESEARCH ACTIVITY

Biosystems Engineering/Biotransport.

Medical device design and development, physiological transport phenomena, mathematical simulation of physiological processes, cardiac assistance, cardiovascular engineering, and immunomodulation.

Biomaterials. Hard tissue fixation, development of biocompatibility indices, blood/material interactions, and tissue/material interactions. Scanning probe characterizations.

Bioinstrumentation. Medical diagnostic and therapeutic instrumentation, noninvasive medical imaging, biosensors, bioelectric signal processing, cardiac electrophysiology, bioelectronic device design, bioelectronics, and neurostimulation.

Biomechanics and Biocontrol. Optimal strategies for human movement, head and neck coordination/movement, gait analysis, control of anthropotic and neuroprosthetic systems, and control

strategies for patients with spinal cord injuries. Rehabilitation engineering, aids for the handicapped. Orthopedic replacement devices, orthotic devices, spinal biomechanics, and sport biomechanics.

Biotechnology. Hybrid biosensors, biological separations, tissue engineering, membrane separation processes, and optical biomolecular devices.

Neuroengineering. Neuromuscular stimulation, neuroprosthesis development, and neurocontrol.

BIOENGINEERING (BME)

BME 411 Biomedical Engineering I. (3) F Review of diagnostic and prosthetic methods using engineering methodology. Introduction to transport, metabolic, and autoregulatory processes in the human body. Prerequisite with a grade of "C" or higher: BME 334.

BME 412 Biomedical Engineering II. (3) S Review of electrophysiology and nerve pacing applications, introduction to biomechanics and joint/limb replacement technology, cardiovascular and pulmonary fluid mechanics, and the application of mathematical modeling. Prerequisite: instructor approval.

BME 415 Biomedical Transport Processes. (3) A Principles of momentum, heat, and mass transport with applications to medical and biological systems and medical device design. Prerequisites: MAT 274; PHY 131.

BME 416 Biomechanics. (3) F Mechanical properties of bone, muscle, and soft tissue. Static and dynamic analysis of human movement tasks such as locomotion. Prerequisite with a grade of "C" or higher: BME 318.

BME 417 Biomedical Engineering Capstone Design I. (3) F Technical, regulatory, economic, legal, social, and ethical aspects of medical device systems engineering design. Lecture, field trips. Prerequisites with a grade of "C" or higher: BME 318, 334.

BME 419 Biocontrol Systems. (3) F Application of linear and nonlinear control systems techniques toward analysis of neuromusculoskeletal, cardiovascular, thermal, and mass transfer systems of the body. Prerequisites: ECE 301; MAT 274.

BME 435 Physiology for Engineers. (4) F Physiology of the nervous, muscular, cardiovascular, endocrine, renal, and respiratory systems. Emphasizes use of quantitative methods in understanding physiological systems. Lecture, lab. Prerequisites: BIO 181 and CHM 116 and PHY 131 or instructor approval.

BME 470 Microcomputer Applications in Bioengineering. (4) S Use of microcomputers for real-time data collection, analysis, and control of experiments involving actual and simulated physiological systems. Lecture, lab. Prerequisites: ECE 100, 334. Prerequisite with a grade of "C" or higher: BME 435.

BME 511 Biomedical Engineering. (3) A Diagnostic and prosthetic methods using engineering methodology. Transport, metabolic, and autoregulatory processes in the body.

BME 512 Biomedical Engineering II. (3) A Electrophysiology and nerve pacing applications, introduction to biomechanics and joint/limb replacement, technology, cardiovascular and pulmonary fluid mechanics, and mathematical modeling.

BME 513 Biomedical Instrumentation I. (3) A Principles of medical instrumentation. Studies of medical diagnostic instruments and techniques for the measurement of physiologic variables in living systems.

BME 514 Advanced Biomedical Instrumentation. (3) F Principles of applied biophysical measurements using bioelectric and radiological approach. Prerequisites: ECE 334; MAT 274 (or equivalent).

BME 515 Biomedical Transport Processes. (3) N Principles of momentum, heat, and mass transport with applications to medical and biological systems and medical device design. Prerequisite: instructor approval.

BME 516 Topics in Biomechanics. (3) F Mechanical properties of bone, muscle, and soft tissue. Static and dynamic analysis of human movement tasks, including in-depth project. Prerequisite: instructor approval.

BME 518 Introduction to Biomaterials. (3) S Topics include structure property relationships for synthetic and natural biomaterials, biocompatibility, and uses of materials to replace body parts. Prerequisite: ECE 350 or equivalent or instructor approval.

BME 519 Topics in Biocontrol Systems. (3) F Linear and nonlinear control systems analysis of neuromusculoskeletal, cardiovascular, thermal, and mass transfer systems of the body, including in-depth project. Prerequisites: ECE 301 and MAT 274 or instructor approval.

BME 520 Bioelectric Phenomena. (3) N Study of the origin, propagation, and interactions of bioelectricity in living things; volume conductor problem, mathematical analysis of bioelectric interactions, and uses in medical diagnostics.

BME 521 Neuromuscular Control Systems. (3) S Overview of sensorimotor brain structures. Application of nonlinear, adaptive, optimal, and supervisory control theory to eye-head-hand coordination and locomotion.

BME 522 Biosensor Design and Application. (3) A Theory and principles of biosensor design and application in medicine and biology. Principles of measurements with biosensors. Prerequisite: instructor approval.

BME 523 Physiological Instrumentation Lab. (1) F Laboratory experience with problems, concepts, and techniques of biomedical instrumentation in static and dynamic environments. Lab. Pre- or corequisites: AGB/BME 435; BME 413; ECE 334.

BME 524 Fundamentals of Applied Neural Control. (3) A Fundamental concepts of electrical stimulation and recording in the nervous system with the goal of functional control restoration. Pre- or corequisite: BME 435 or instructor approval.

BME 525 Surgical Techniques. (2) S

Principles of surgical techniques, standard operative procedures, federal regulations, guidelines, and state-of-the-art methods. Lecture, lab.

BME 532 Prosthetic and Rehabilitation Engineering. (3) A

Analysis and critical assessment of design and control strategies for state-of-the-art medical devices used in rehabilitation engineering. Pre- or corequisite: BME 416 or 516 or EPE 610.

BME 533 Transport Processes I. (3) F

Unified treatment of momentum, heat, and mass transfer from molecular theory, and continuum points of view. Continuum equations of microscopic and macroscopic systems and multicomponent and multiphase systems. Cross-listed as CHE 533.

BME 534 Transport Processes II. (3) S

Continuation of BME/CHE 533, emphasizing mass transfer. Cross-listed as CHE 534. Pre-requisite: BME/CHE 533.

BME 543 Thermodynamics of Chemical Systems. (3) F

Classical and statistical thermodynamics of nonideal physicochemical systems and processes; prediction of optimum operating conditions. Cross-listed as CHE 543.

BME 544 Chemical Reactor Engineering. (3) S

Reaction rates, thermodynamics, and transport principles applied to the design and operation of chemical reactors. Cross-listed as CHE 544. Prerequisite: BME/CHE 543.

BME 551 Movement Biomechanics. (3) S

Mechanics applied to the analysis and modeling of physiological movements. Computational modeling of muscles, tendons, joints, and the skeletal system with application to sports and rehabilitation. Prerequisite: BME 416 or 516 or instructor approval.

BME 566 Medical Imaging Instrumentation. (3) N

Design and analysis of imaging systems and nuclear devices for medical diagnosis, therapy, and research. Laboratory experiments using diagnostic radiology, fluoroscopy, ultrasound, and CAT scanning. Lecture, lab. Prerequisite: instructor approval.

BME 567 Radiation Shielding and Transport. (3) F

Shielding for radiation therapy, diagnostic radiology, cyclotrons, and nuclear reactors. Monte Carlo and empirical computational methods, regulations, and design problems. Cross-listed as EEE 567. Prerequisite: EEE 465.

BME 568 Medical Imaging. (3) S

CT, SPECT, PET, and MRI. 3-dimensional *in vivo* measurements. Instrument design, physiological modeling, clinical protocols, reconstruction algorithms, and quantitation issues. Prerequisite: instructor approval.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

Biology

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Chair

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REGENTS' PROFESSORS

ALCOCK, MARKOW

PROFESSORS

CAPCO, CHANDLER, CHURCH,
COLLINS, FAETH, FISHER, HAZEL,
HEDRICK, LAWSON, MAIENSCHIN,
McGAUGHEY, MINCKLEY, MOORE,
OHMART, RISSING, RUTOWSKI,
SATTERLIE, A. SMITH, WALSBURG

ASSOCIATE PROFESSORS

CARROLL, DOWLING, ELSER,
FOUQUETTE, GOLDSTEIN, GRIMM,
HARRISON, G. SMITH

ASSISTANT PROFESSORS

FAGAN, FEWELL, NEWFELD,
ORCHINI, RAWLS

RESEARCH PROFESSOR

PEARSON

RESEARCH ASSOCIATE PROFESSOR

DAVIDSON

RESEARCH ASSISTANT PROFESSOR

WILSON-RAWLS

ACADEMIC PROFESSIONAL

DOUGLAS

The faculty in the Department of Biology offer programs leading to the M.S. and Ph.D. degrees in Biology. A concentration in ecology is available, among other areas of study.

The faculty collaborate with the Departments of Microbiology and Plant Biology in offering the program leading to the Master of Natural Science degree when one of the concentrations is biology (see page 110).

Students admitted to the Master of Education degree program with a major in Secondary Education may also elect biology as the subject matter field.

These programs are designed to prepare students for careers in teaching and research in educational, medical, industrial, and governmental institutions.

Graduate Record Examination. Submission of scores on the verbal, quantitative, analytical, and advanced sections of the Graduate Record Examination is required for admission to the M.S. and Ph.D. degree programs.

Application Deadline. Completed college and departmental application materials should be received by January 15 for admission in the fall semester.

MASTER OF SCIENCE

The program of each student is prepared in consultation with the supervisory committee, consisting of a major professor and two additional faculty members. A minimum of 30 semester hours is required. The program must include six hours of thesis, one hour of seminar, and may include a maximum of eight additional hours in various special graduate courses such as research and reading and conference. A final oral examination covering the thesis and related subject matter is administered by the supervisory committee.

DOCTOR OF PHILOSOPHY

The Ph.D. program in the Department of Biology allows the student to acquire high research competency in one or more specialized areas while receiving a broad, solid grounding in biological sciences.

See pages 120–122 for general requirements.

Program of Study. The program of study is planned by the student and the supervisory committee, consisting of a major professor and four additional faculty members. The program is tailored to the needs of the individual student.

Foreign Language Requirements.

None are required by the department. However, each student's supervisory committee may specify a reading proficiency in one or more foreign languages if appropriate to the student's educational objectives.

Comprehensive Examinations. The comprehensive examination consists of a written and oral component. To advance to candidacy for the Ph.D., the student must successfully complete three graduate seminars in areas different from the major area of emphasis; one of these must be a 2 credit writing seminar completed by the end of the

third semester (see topics outlines under "Research Activity"). The seminars include evaluation of synthetic writing skills. A synthetic, detailed research proposal must be completed by the fourth semester. The student must defend the proposal orally to the supervisory committee within three weeks after successful completion of the written research proposal.

Dissertation Requirements. A dissertation based on original research is required. (See dissertation requirements, page 119.)

Final Examinations. A final defense of the dissertation is required (see page 119). The defense consists of a public seminar followed by an oral examination administered by the student's supervisory committee.

RESEARCH ACTIVITY

Research of faculty and graduate students includes a wide range of biological topics. Current research interests within the department include:

Cell and Molecular Biology. Protein synthesis; cytoskeleton assembly; localization of RNA in oocytes and embryos; regulation of exocytosis and endocytosis; cell division; cell-cell interaction; electron microscopy; recombinant DNA; gene mapping; analysis of cloned developmentally regulated genes; regulation of gene expression in eukaryotes; mechanisms of interferon action.

Developmental Biology. Cell and organ differentiation; regulation; development of synapses; developmental genetics; control of oogenesis; in vitro fertilization.

Genetics. Molecular and developmental genetics; genetic regulatory mechanisms of cellular differentiation; chromosomal ultrastructure and function; behavioral genetics; variation in natural populations; human population genetics; molecular evolutionary genetics.

Physiology. Membrane metabolism and function, thermal adaptation, regulation, and ion transport; tissue, epithelial, and cuticular function; comparative endocrinology; neurophysiology; environmental physiology especially related to desert adaptations.

Evolution. Population genetics, molecular evolution, systematics, specia-

tion, evolution of behavior, morphological diversification.

Behavior. Reproductive behavior; sexual selection; communication; neural and hormonal mechanisms of behavior; behavioral ecology; behavioral genetics.

Ecology. Life histories, dispersal, and foraging; plant-animal interactions; community structure; biogeography; physiological ecology; ecosystems structure and functioning; wildlife fisheries management. Research in terrestrial and aquatic desert habitats reflects the unique location of ASU.

History and Philosophy of Biology. The nature of biological science and the way science changes; who does biology and why; what assumptions do biologists make and how they influence the research done; questions about funding, institutions, and the social context for biology.

Biology Education. Student reasoning patterns and alternative conceptual frameworks; the nature of scientific reasoning; learning styles, instructional techniques, and issues in curriculum development.

Facilities. The modern Life Science Center houses well-equipped research laboratories and teaching facilities. The Life Sciences Electron Microscopy Laboratory includes both scanning and transmission electron microscopes as well as a freeze-fracture unit. Housing of laboratory animals and maintenance of breeding colonies are provided by the Animal Research Center. Arizona fauna is well represented in departmental collections. Desert, montane, riparian, and lacustrine habitats are within driving distance; species diversity is high.

BIOLOGY (BIO)

BIO 406 Computer Applications in Biology. (3) F

Computer analysis techniques in biology, emphasizing data entry, graphic portrayal, and management and analysis. Employs mainframe and microcomputers. Credit is allowed only for BIO 406 or PLB 432. Cross-listed as PLB 432. Prerequisites: BIO 182 and MAT 117 (or 210) or instructor approval. *General Studies: N3.*

BIO 410 Techniques in Wildlife Conservation Biology. (3) F

Field and analytical techniques used in evaluating population structure, viability and environmental impacts. Lecture, lab. Prerequisites: BIO 217 and 320 or instructor approval. *General Studies: L2.*

BIO 411 Advanced Conservation Biology I. (3) F

Principles of conservation science; biology of threatened species; management principles that meet conservation goals; emphasizing North American ecosystems. Prerequisites: BIO 217, 320.

BIO 412 Advanced Conservation Biology II. (3) F

Global biodiversity patterns, processes and conservation; global environmental change; sustainable use of natural resources; emphasizing international approaches to conservation biology. Prerequisites: BIO 217, 320.

BIO 415 Biometry. (4) F

Statistical methods applied to biological problems, design of experiments, estimation, significance, analysis of variance, regression, correlation, chi square, and bioassay; the use of computers. Does not satisfy laboratory requirements for the liberal arts general studies program. 3 hours lecture, 3 hours lab. Prerequisite: MAT 210 or equivalent. *General Studies: N2.*

BIO 416 Professional Values in Science. (2-3) A

Considers issues related to values in science such as collaboration, finances, legal issues, media, mentoring, ownership of ideas, scientific integrity. Discussion, student projects. Cross-listed as HPS 410. *General Studies: L2.*

BIO 423 Population and Community Ecology. (3) N

Organization and dynamics of population and communities, emphasizing animals. Theoretical and empirical approaches. Prerequisite: BIO 320 or instructor approval.

BIO 425 Animal Ecology. (3) N

Physiological and behavioral adaptations of individual animals to both abiotic and biotic environments. Prerequisite: BIO 320.

BIO 426 Limnology. (4) S

Structure and function of aquatic ecosystems, with emphasis on freshwater lakes and streams. 3 hours lecture, 3 hours lab or field trip. Prerequisite: BIO 320 or instructor approval. *General Studies: L2.*

BIO 428 Biogeography. (3) F

Environmental and historical processes determining distributional patterns of animals and plants, emphasizing terrestrial life. Prerequisites: BIO 182 (or equivalent); junior standing. *General Studies: L2.*

BIO 435 Research Techniques in Animal Behavior. (3) S 1999

Experimental and field studies of animal behavior; description and quantification of animal behavior and interpretation of behavior within an evolutionary framework. 1 hour lecture, 6 hours lab. Prerequisite: BIO 280. *General Studies: L2.*

BIO 441 Cytogenetics. (3) F 1999

Chromosomal basis of inheritance. Cross-listed as PLB 412. Prerequisite: BIO 340.

BIO 442 Cytogenetics Laboratory. (2) F 1999

Microscopic analysis of meiosis, mitosis, and aberrant cell division. 6 hours lab. Cross-listed as PLB 413. Pre- or corequisite: BIO 441 or PLB 412.

BIO 445 Organic Evolution. (3) F

Processes of adaptive change and speciation in sexual populations. Prerequisite: BIO 241 or 340.

BIO 446 Principles of Human Genetics. (3) A

Genetics in human populations, including medical aspects. Prerequisite: BIO 340. *General Studies: L2.*

BIO 450 Advanced Developmental Biology. (3) S

Current concepts and experimental methods involving differentiation and biosynthetic activities of cells and organisms, with examples from microorganisms, plants, and animals. Prerequisite: BIO 351.

BIO 453 Animal Histology. (4) S

Microscopic study of animal tissues. 3 hours lecture, 3 hours lab. Prerequisite: BIO 182 or instructor approval.

BIO 454 Aquatic Insects. (3) N

Systematics and ecology of aquatic insects. Prerequisite: BIO 386.

BIO 464 Photobiology. (3) F 1998

Principles underlying the effects of light on growth, development, and behavior of plants, animals, and microorganisms. Cross-listed as PLB 440. Prerequisites: CHM 231 (or 331); 12 hours of courses in life sciences.

BIO 465 Neurophysiology. (3) S 2000

Detailed treatment of cellular and organismal neurophysiology and nervous system function. Prerequisite: BIO 360.

BIO 466 Neurophysiology Laboratory. (2) S 2000

Intracellular and extracellular electrophysiological recording techniques, histological preparations, and dye-filling techniques. 6 hours lab. Pre- or corequisite: BIO 465.

BIO 470 Systematic Zoology. (4) S 1999

Philosophy, theory, practice of interpreting animal diversity, including species concepts, speciation, nomenclature, and evolutionary and phylogenetic classification emphasizing phylogenetics. 3 hours lecture, 3 hours lab. Prerequisites: junior standing; 18 hours in life sciences. *General Studies: L2.*

BIO 471 Ornithology. (3) S

The biology of birds. 2 hours lecture, 3 hours lab, weekend field trips. Prerequisite: BIO 370 or instructor approval.

BIO 472 Mammalogy. (4) F 1998

Classification, structure, habits, ecology, and distribution of mammals, emphasizing North American forms. 3 hours lecture, 3 hours lab or field trip, weekend field trips. Prerequisite: BIO 370 or instructor approval.

BIO 473 Ichthyology. (3) S 1999

Systematics and biology of recent and extinct fishes. 2 hours lecture, 3 hours lab or field trip, weekend field trips required. Prerequisites: BIO 370 and 425 or instructor approval.

BIO 474 Herpetology. (3) S 2000

Systematics and biology of recent and extinct reptiles and amphibians. 2 hours lecture, 3 hours lab or field trip. Prerequisite: BIO 370.

BIO 480 Methods of Teaching Biology. (3) S
Methods of instruction, experimentation, organization, and presentation of appropriate content in biology. Prerequisite: 20 hours in the biological sciences.

BIO 495 Undergraduate Thesis. (3) F, S, SS
Guided research culminating in the preparation of an undergraduate thesis based on supervised research done in this and previous semesters. Prerequisites: at least 3 hours of BIO 310 (or 499); formal conference with instructor; instructor and department chair approval.

BIO 502 Transmission Electron Microscopy. (3) F

Theory, use, and methods of preparing biological materials for transmission electron microscopy. Materials fee. Lecture, lab. Prerequisite: instructor approval.

BIO 505 Scanning Electron Microscopy. (3) S

Theory, use, and methods of preparing biological materials for scanning electron microscopy. Materials fee. 2 hours lecture, 3 hours lab. Prerequisite: instructor approval.

BIO 508 Scientific Data Presentation. (2) S

Techniques necessary for presentation of scientific data used in journal publications, grant proposals, and visual presentations. Lecture, lab. Prerequisite: instructor approval.

BIO 520 Biology of the Desert. (2) N

Factors affecting plant and animal life in the desert regions and adaptations of the organisms to these factors. Prerequisite: 10 hours of biological sciences or instructor approval.

BIO 522 Populations: Evolutionary Ecology. (3) S

Principles of population biology and community ecology within an evolutionary framework. 2 hours lecture, 2 hours recitation. Prerequisites: BIO 320, 415 (or MAT 210), 545.

BIO 524 Ecosystems. (3) F 1999

Structure and function of terrestrial and aquatic ecosystems, with emphasis on productivity, energetics, biogeochemical cycling, and systems integration. Prerequisite: BIO 320 or equivalent.

BIO 526 Quantitative Ecology. (3) N

Sampling strategies, spatial pattern analysis, species diversity, classification, and applications of multivariate techniques to ecology. 2 hours lecture, 3 hours lab. Prerequisites: BIO 415 (or equivalent); a course in ecology.

BIO 529 Advanced Limnology. (3) N

Recent literature, developments, methods, and limnological theory; field and lab application to some particular topic in limnology. Prerequisite: BIO 426.

BIO 543 Molecular Genetics. (3) F

Nature and function of the gene; emphasis on the molecular basis of inheritance and gene expression in prokaryotes and eukaryotes. Prerequisites: BIO 340; a course in organic chemistry.

BIO 545 Populations: Evolutionary Genetics. (3) F

Mathematical models in the description and analysis of the genetics of populations. Prerequisites: BIO 320 and 415 and 445 or instructor approval.

BIO 547 Techniques in Evolutionary Genetics. (4) S

Practical experience in modern techniques for the study of evolution. Lecture, lab. Prerequisites: BIO 340, 445; instructor approval.

BIO 550 Advanced Cell Biology. (3) S

Applications of contemporary electron microscopic and biochemical/molecular techniques for studying eukaryotic cell functions. Mechanisms of intracellular protein trafficking. Prerequisites: BIO 353 (or 360 or equivalent or PLB 360); CHM 231 (or 331 or equivalent).

BIO 551 Biomembranes. (3) N

Structure and function of biological membranes, emphasizing synthesis, fluidity, exocytosis, endocytosis, and cell responses to hormones and neurotransmitters. Prerequisites: BIO 353 (or equivalent); CHM 231 (or 331 or equivalent).

BIO 552 Developmental Genetics. (3) F 1998

Genetic approaches to the analysis of development during the life cycle of eukaryotic organisms, and the role of genes in the unfolding of the differentiated phenotype. Prerequisite: BIO 340.

BIO 560 Comparative Physiology. (3) S 1999

The analysis of function in invertebrates and vertebrates, emphasizing evolutionary trends in physiological systems. Prerequisite: BIO 360 or equivalent.

BIO 566 Environmental Physiology. (3) S 2000

Physiological responses and adaptations of animals to various aspects of the physical environment. Prerequisites: BIO 320, 360.

BIO 568 Mammalian Physiology. (3) F 1999

Detailed treatment of mammalian organ system functions emphasizing integrative mechanisms. Prerequisite: BIO 360 or equivalent.

BIO 569 Cellular Physiology. (3) F 1998

Emphasizing the molecular basis for cell structure and function. Prerequisites: BIO 360; organic chemistry.

BIO 584 Internship. (1–12) F, S**BIO 591 Seminar.** (1–3) F, S

Topics such as the following are offered:

- (a) Adaptations
- (b) Behavior
- (c) Cell Biology
- (d) Ecology
- (e) Evolution
- (f) Genetic Engineering
- (g) Genetics
- (h) Physiology

May be repeated for credit.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

Building Design

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Director

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REGENTS' PROFESSOR COOK

PROFESSORS

BOYLE, EL DIASTY, McCOY,
McSHEFFREY, MEUNIER,
PETERSON, RAPP,
SCHEATZLE, UNDERHILL

ASSOCIATE PROFESSORS

HARTMAN, KUPPER, LOOPE,
McINTOSH, OZEL, SHEYDAYI,
UNDERWOOD, ZYGAS

ASSISTANT PROFESSORS

ELLIN, KROLOFF,
SOROKA, VAN DUZER

RESEARCH PROFESSOR

JONES

The faculty in the School of Architecture offer a graduate program leading to the M.S. degree in Building Design. Concentrations are available in computer-aided design, energy performance and climate-responsive architecture, and facilities development and management. The program provides advanced study at the postprofessional level for architects, and at the specialist level for nonarchitects who have a degree in a related area such as engineering, business, computer science, and the physical and environmental sciences. The purpose of the program is the development of knowledge useful to the arts and sciences of building design and the integration of that knowledge in the design process. Within this context, the program emphasizes (1) the ecological importance of energy-conscious design and construction, as well as the high social value placed on buildings in which natural forces and systems are utilized rather than suppressed, and (2) the development of research, information systems and management processes suited to the planning and design of complex buildings in urban settings.

The faculty in the school also participate in offering the Ph.D. in Environmental Design and Planning. See pages 198–200 for information on the Ph.D. degree program.

MASTER OF SCIENCE

Admission Requirements

Applicants considered for admission to the program must hold a baccalaureate or graduate degree from a college or university recognized by ASU and meet the minimum GPA and requirements for admission established by the Graduate College.

It is preferred that applicants have at least one year of professional employment or comparable field/research experience in building design in addition to their academic experiences. Applicants are accepted on a space-availability basis, and must specify an area of research concentration upon application. International applicants whose native language is not English must submit a Test of English as a Foreign Language score of 550 or higher. International students should write the Graduate Admissions Office at least one year prior to the date they plan to begin study.

Application Procedures. Applicants must submit separate application materials to the Graduate College and the School of Architecture. Application deadline is January 15.

School of Architecture. In addition to the Graduate College admission requirements, applicants must file all of the following admission materials with the graduate secretary, Master of Science degree in Building Design, School of Architecture, Arizona State University, Tempe, Arizona 85287-1605. Applicants are encouraged to contact the graduate secretary to ascertain that all materials have been received, at 602/965-2507.

Statement of Intent. A personal narrative (maximum 600 words or two pages typed) indicating the applicant's interest, previous academic and practical background, and personal and professional educational objectives must be submitted.

Letters of Recommendation. A minimum of three letters of recommendation in support of the applicant must be

mailed directly to the Graduate Admissions Committee, School of Architecture. The references should be from professionals or educators familiar with the applicant's experience and capability for graduate work.

Portfolio. Applicants must submit a folio documenting projects, papers, creative endeavors, and, if appropriate, work experience (maximum size 9" x 12").

The portfolio is returned after final admission procedures, *provided* the applicant encloses a self-addressed return mailer with sufficient prepaid postage, or if the applicant appears in person to claim the materials within one year of submission. Unclaimed portfolios are retained for only one year. The School of Architecture assumes no liability for lost or damaged materials. Students must have their name clearly visible on all parts of application, portfolio, statement of intent, etc.

Research Teaching Statement. Students wishing to be considered for teaching or research assistantships should include an additional statement outlining areas in which they feel competent to serve as a teaching or research assistant. International students who wish to be considered for a teaching assistantship and whose native language is not English are required to pass the Test of Spoken English administered by the American English and Culture Program at ASU.

Program of Study. The program requires a minimum of 30 semester hours of approved course work at the advanced level, including six hours of thesis credit.

The M.S. degree in Building Design is based on concepts of research and decision-making emphasized by the College of Architecture and Environmental Design.

Students admitted to the program are required to take a research methods core, certain courses in their area of concentration, additional elective course work as approved and directed by the supervisory committee, and write and defend a thesis. While the minimum requirement is 30 semester hours, most students require at least four semesters of course work and work on their thesis to successfully complete this degree program.

The concentrations include the following: computer-aided design, energy performance and climate-responsive architecture, and facilities development and management.

Computer-Aided Design and Facilities Development and Management Concentrations

Research methods core	6
Area of concentration requirements	6
Approved electives	12
Thesis	6
Minimum total	30

The *computer-aided design* concentration features investigations of computer-aided design methods and techniques and their application to problem-solving issues in the built environment. The goal of the program is to provide a fundamental understanding of computer-aided design methods and to explore critically the application and potential of these techniques in practice. Topics studied include computer graphics, geometric modeling, design databases, interactive graphic environments for design, comprehensive computer-aided design systems, computer-aided energy-conscious design and analysis, databases for facilities planning, and computer applications in urban design and building construction. The computer-aided design requirements (six semester hours) consist of ANP 530 Computer Graphics in Architecture and ANP 598 ST: Computer-Aided Design Methods.

The *facilities development and management* concentration is concerned with the decision-making processes in building development and design firm management. The goal of the program is the advancement of knowledge about the interactions between design and managerial processes. This concentration addresses the following topics: spatial decision models, building development processes and financing, market structure and strategy, pricing and cost control, design automation and group decision-making, architectural programming and post-occupancy evaluation, and professional ethics. The program benefits from ties to various professional groups and other academic units concerned with business and facilities management. The facilities development and management requirements (six semester hours) consist of AAD 552 Architectural Management

II or AAD 555 Architect as Developer, and AAD 593 Applied Projects.

Energy Performance and Climate-Responsive Architecture Concentration

Research methods core	6
Area of concentration requirements	12
Approved electives	6
Thesis	6
Minimum total	30

The energy performance and climate-responsive architecture concentration is concerned with the relationships among climate and site, thermal and visual comfort, and energy demand and consumption. Courses in this concentration establish a basic core of knowledge on the principles of the natural energies available at the building boundary due to climate and site; thermal and optical behavior of building materials and components; passive and low-energy architectural systems for heating, cooling, and lighting; and appropriate integration with mechanical systems. Additional courses are available to support advanced study and research in a variety of related specialties.

Examples of the areas of advanced study that are available are climate-responsive architecture and analysis of building energy performance. In climate-responsive architecture, a student applies the principles of "bioclimatic" building design in a studio setting to maximize the use of renewable energy resources in particular locations and building programs. In analysis of building energy performance, a student applies physical and economic analysis, computer simulation, and/or measurement as tools in determining component or whole-building performance relative to energy, climate, and cost-efficiency. The student is concerned with climate responsive, low-energy building design through resource-efficient building concepts, materials, components, and systems such as daylighting, passive solar heating, passive cooling, and earth sheltering.

Most students address these problems with an emphasis on either a design-oriented approach in a studio setting or with an emphasis on an analysis-oriented approach through the application of the most current building energy simulation and analysis tools. Some students want to combine these approaches in their thesis problem. The energy performance and climate-

responsive architecture requirements (six semester hours) consist of ATE 521 Building Environmental Science and ATE 582 Environmental Control Systems.

Foreign Language Requirements. None.

Thesis Requirements. A thesis is required. Each candidate devotes research effort of six semester hours of thesis/research credit in preparation of a thesis. The thesis must conform to School policies and meet Graduate College format requirements.

Final Examinations. A final oral examination in defense of the thesis is required.

RESEARCH ACTIVITY

Faculty and students in the graduate programs of the School of Architecture may be involved in the following areas of research: solar architecture design, energy performance in buildings, computer-aided design and graphics, facilities development and management, environments for aging, housing, urban design, building technology, environmental analysis and programming, passive cooling and heating, ecotechniques, arid region building and systems design, and architectural history.

The College of Architecture and Environmental Design maintains 1,500-square feet of rooftop testing laboratory for solar research.

The college's Research and Service Foundation provides facilities for basic research and community service activities in energy technology, design, and planning.

BUILDING DESIGN

For courses supporting the Building Design major, see pages 142-143.

Business Administration

The faculty in the College of Business offer a Ph.D. degree in Business Administration, a Master of Business Administration (M.B.A.) degree, and an M.B.A. for Executives program.

Other professional master's degrees offered through the College of Business are described in this catalog under their respective degree program headings.

MASTER OF BUSINESS ADMINISTRATION

The M.B.A. program is supported by academic units within the College of Business. For a description, refer to pages 61–64.

DOCTOR OF PHILOSOPHY

The Ph.D. degree in Business Administration prepares candidates for scholarly careers at leading educational institutions and for positions in business and government organizations where advanced research and analytical capabilities are required. Major emphasis is placed upon the development of expertise in a chosen subject area, a disciplined and inquiring mind, competence in research methodology, and skill in effectively communicating advanced business concepts.

Students are encouraged to work closely with the faculty from the beginning of their programs. A ratio of resident doctoral students to faculty of less than one to one ensures that faculty may serve effectively as mentors for doctoral students.

Admission. A completed application for admission to the Ph.D. in Business Administration degree program includes

1. application for admission to the Graduate College,
2. undergraduate and postgraduate transcripts,

3. Graduate Management Admission Test score or scores from the Graduate Record Examination,
4. applicant's letter of personal career objectives and rationale for pursuing the Ph.D. program,
5. three letters of recommendation,
6. Test of Spoken English score for applicants whose native language is not English, and
7. Test of English as a Foreign Language score for applicants whose native language is not English and who have not completed a degree from a U.S. college or university.

Admission is granted for fall semesters only. The deadline for receipt of all required application materials is February 1.

Areas of Concentration. The Ph.D. student may choose from among seven areas of concentration: accountancy, finance, health services research, information management systems, management, marketing, and supply chain management. The *accountancy* specialization area includes financial accounting, managerial accounting, tax policy, auditing, and information systems. Research activities in *information management* encompass areas of theory and application in computer information systems. Research interests of the finance faculty offering the *finance* concentration focus on corporate finance, investments, financial markets, and banking. *Health services research* focuses on organization, delivery and financing of health services, and on the relationships of structures and processes of health services to outcomes such as quality of care and health status changes. The *management* concentration requires three core courses: organizational theory, organizational behavior, and research methodology. In addition to these core courses, students choose one of two specialty tracks: strategic management or human resource management. Research conducted by the marketing faculty offering the *marketing* concentration is focused in several areas: advertising, buyer behavior, distribution channels, services marketing, and other dimensions of marketing, including sales management, industrial marketing, and public-policy implications of market-

ing. The supply chain management faculty in the Department of Business Administration offer the *supply chain management* concentration and are actively involved in the input-conversion-output process.

Program of Study. See pages 120–122 for general requirements. The Ph.D. degree program requires mathematical competence through linear algebra and calculus and computer skills. The program of study includes graduate study in economics, behavioral sciences, and quantitative/statistical analysis. The advanced program is composed of an area of concentration and supporting course work that best prepares students for conducting scholarly work in their areas of interest.

Comprehensive Examinations. A written comprehensive examination, designed to ascertain the candidate's knowledge and orientation in the major field of study and fitness to proceed to the completion of a dissertation, is required at the end of course work. An additional written comprehensive examination on a candidate's supporting course work is a departmental option. An oral examination after completion of written examinations is also a departmental option.

Dissertation Requirements. The candidate must present an acceptable dissertation based on original investigation. The dissertation must represent a significant contribution to knowledge, be written in a scholarly manner, and demonstrate the ability of the candidate to do independent research of high quality.

Final Examinations. A final oral examination in defense of the dissertation is required. The examination covers the subject matter of the dissertation and the field most nearly corresponding with that of the dissertation.

School of Accountancy and Information Management

For faculty, research activity, and courses, refer to pages 123–124.

Department of Business Administration

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PROFESSORS

J. CARTER, P. CARTER,
 GUNTERMANN, HENDRICK,
 JENNINGS, METCALF, SMELTZER

ASSOCIATE PROFESSORS

ARANDA, BOHLMAN, BUTLER,
 DAVIS, DUNDAS, ELLRAM,
 LEONARD, LOCK, LYNCH,
 MURRANKA, PEARSON, SIFERD

ASSISTANT PROFESSOR

MALTZ

SENIOR LECTURERS

FLYNN, GEISS

RESEARCH ACTIVITY

The faculty in the Department of Business Administration have a strong commitment to scholarly research in a wide variety of areas. Although the faculty have published in a number of business and interdisciplinary journals, the research can generally be divided into four areas: business law, management communication, supply chain management, and real estate.

The business law faculty have been conducting research on antitrust and labor disputes in the sports industry, standards of disclosure, strategic legal planning, and commercial contract negotiations. The relationship between business law and business ethics is a major focus of this group. Collaborative writing, negotiations, and patterns of strategies for communicating organizational change are some of the areas in which management communication faculty are conducting research.

The research conducted by supply chain management faculty includes purchasing performance, forecasting, vendor evaluation, contract negotiation, materials management and acquisition, transportation regulation and policy, in addition to other related areas. In the area of real estate, research topics include the impact of discount points on

housing value, a rational expectations model of housing price, the time on the market, inflation, interest rates, and cost of housing.

BUSINESS ADMINISTRATION (BUS)

BUS 431 Business Report Writing. (3) N
 Organization and preparation of reports incorporating electronic databases, word processing, and graphics. Prerequisite: BUS 301.

BUS 451 Business Research Methods. (3) N
 Methods of collecting information pertinent to business problem solving, including design, collection, analysis, interpretation, and presentation of primary and secondary data.
General Studies: L2.

BUS 502 Managerial Communication. (1-3) F, S
 Analysis of various business problems, situations, and development of appropriate communication strategies. Prerequisite: MGT 502.

BUS 504 Professional Report Writing. (3) A
 Preparation and presentation of professional reports.

BUS 507 Business Research Methods. (3) N
 Techniques for gathering information for business decision making. Selection, design, and completion of a business-oriented research project.

BUS 591 Seminar. (3) N
 Selected managerial communication topics.

BUS 594 Study Conference or Workshop. (3) N

BUS 700 Research Methods. (3) N
Omnibus Graduate Courses: See pages 51-52 for omnibus graduate courses that may be offered.

LEGAL AND ETHICAL STUDIES (LES)

LES 411 Real Estate Law. (3) A
 Legal and ethical aspects of land ownerships, interests, transfer, finance development and regulations of the real estate industry.

LES 532 Negotiation Agreements. (3) F, S
 Course develops negotiation competencies to build partnerships and create lasting agreements with internal/external customers, suppliers, work teams, and external constituencies. Lecture and substantial student interaction through team exercises.

LES 579 Legal and Ethical Issues for Business. (3) F, S

Study of legal and ethical components of business decisions; self-regulation and social responsibility as strategies. Prerequisites: ACC 503; FIN 502; MGT 502; MKT 502.

Omnibus Graduate Courses: See pages 51-52 for omnibus graduate courses that may be offered.

REAL ESTATE (REA)

REA 401 Real Estate Appraisal. (3) A
 Factors affecting the value of real estate. Theory and practice of appraising and preparation of the appraisal report. Appraisal techniques. Prerequisites: REA 300; professional program business student.

REA 441 Real Estate Land Development.

(3) A
 Neighborhood and city growth. Municipal planning and zoning. Development of residential, commercial, industrial, and special purpose properties. Prerequisites: REA 300; professional program business student.

REA 456 Real Estate Investments. (3) A
 Analysis of investment decisions for various property types. Cash flow and rate of return analysis. Prerequisites: FIN 300; professional program business student.

REA 461 Current Real Estate Topics. (3) N
 Current real estate topics of interest are discussed and analyzed. Prerequisites: REA 300; professional program business student.

REA 591 Seminar in Selected Real Estate Topics.

- (3) N
 Topics may be selected from the following:
- Real Estate Development.
 Development process covering feasibility, site selection, planning, design, financing, and construction. Relationship of land use controls and regulations to the private sector.
 - Real Estate Finance and Investments.
 Basic techniques for analyzing the financial feasibility of real estate investments. Includes cash flow, yield and risk analysis; taxation, form of ownership, and management.
 - Real Estate Market Analysis.
 Analytical techniques used in performing market research to assess the feasibility of proposed residential, retail, office, and other developments.
 - Real Estate Research.
 Reviews current research in areas such as market studies, mortgage securitization, valuation, development, investments, and government regulation.

Omnibus Graduate Courses: See pages 51-52 for omnibus graduate courses that may be offered.

SUPPLY CHAIN MANAGEMENT (SCM)

SCM 405 Urban Transportation. (3) N
 Economic, social, political, and business aspects of passenger transportation. Public policy and government aid to urban transportation development. Prerequisite: upper-division standing or instructor approval.

SCM 432 Materials Management. (3) F, S
 Study of managing the productive flow of materials in organizations, including MRPII, JIT, quality, facility planning, and job design. Prerequisites: OPM 301; professional program business student.

SCM 440 Productivity and Quality Management. (3) F, S
 Productivity concepts at the national, organizational, and individual levels. Quality management and its relationship to productivity in all organizations. Prerequisite: professional program business student.

SCM 455 Purchasing Research and Negotiation. (3) F, S

Current philosophy, methods, and techniques used to conduct both strategic and operations purchasing research and negotiation. Includes negotiation simulations. Prerequisites: OPM 301; SCM 432; professional program business student. Prerequisite with a grade of "C" or higher: SCM 355. *General Studies: L2.*

SCM 460 Carrier Management. (3) N

Analysis of carrier economics, regulation, management, and rate-making practice; evaluation of public policy issues related to carrier transportation. Prerequisite: upper-division standing or instructor approval.

SCM 463 International Transportation and Logistics. (3) A

Logistics activities in international business with special emphasis on transportation, global sourcing, customs issues, and facility location in international environment. Prerequisite: SCM 345 or instructor approval.

SCM 479 Purchasing and Logistics Strategy. (3) F, S

Synthesis of purchasing, production, transportation to provide a systems perspective of materials management. Development of strategies. Prerequisites: SCM 345, 432; professional program business student. Prerequisite with a grade of "C" or higher: SCM 355.

SCM 532 Supply Chain Design and Development Strategies. (3) F

A strategic orientation toward the design and development of the supply chain for purchasing, materials, and logistics systems.

SCM 541 Supply Chain Management and Control. (3) S

Management and control of purchasing and logistics management systems. Total Quality Management to assess and assure customer satisfaction. Global strategies.

SCM 545 Supply Chain Continuous Improvement Strategies. (3) S

Leading edge strategies such as reengineering high-performance teams and expert systems for continuous improvement of the supply chain. Seminar.

SCM 591 Seminar. (3) N

Topics such as the following are offered:

- (a) Logistics and Transportation
- (b) Purchasing

SCM 791 Doctoral Seminar. (3) A

Topics may be selected from the following:

- (a) Logistics, Transportation, and Physical Distribution Management.
- (b) Purchasing and Materials Management.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

Department of Economics

For faculty, research activity, and courses, refer to pages 180–183.

Department of Finance

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HOFFMEISTER, MARTIN, WILT

ASSISTANT PROFESSORS

GRIFFIN, LEMMON

LECTURER

OAKES

RESEARCH ACTIVITY

The Department of Finance has a strong commitment to academic and professional research. This emphasis on quality research, both empirical and theoretical, is evidenced by the many ongoing and recently completed studies in the areas of corporate finance, investments, and banking. Topics of some recent studies that are representative of department published research include: bid-ask spreads in the inter-bank foreign exchange markets; cross-exchange comparison of execution costs and information flow for New York Stock Exchange (NYSE)-listed stocks; extracting the value of intangible assets from the unit assessment method; the profitability of technical trading rules in the Asian stock markets; intraday bid-ask spread pattern in the stock and option market; on equilibrium pricing under parameter uncertainty; mean reversion in equilibrium asset prices: evidence from the futures term structure; ownership dispersion, costly information, and IPO underpricing; factors determining the number of outside directorships held by CEOs; causality test of short sales on the NYSE; the degree of price resolution and equity trading costs; the valuation impact of common errors in calculating the weighted average cost of capital; why option prices lag stock prices: a trading-based explanation; contract costs, bank loans and the cross-moni-

toring hypothesis; the intraday relationship between index arbitrage and market volatility; the implications of equity issuance announcements within a parent-subsidiary governance structure; leadership structure: separating the positions of CEO and chairman of the board; an empirical analysis of antitrust legal disputes; empirical examination of information, differences of opinion, and trading activity; causality tests of the real stock return-real activity hypothesis; cost of equity models that meet the needs of the ad-valorem tax analyst; the industry effects of interfirm lawsuits; market discounts and shareholder gains for placing equity privately; quotations, trading costs, and volatility for NYSE and NASDAQ-listed stocks; return autocorrelations around nontrading days; a comparison of the information conveyed by equity carve-outs, spin-offs, and asset sell-offs; is there news in the prime rate?; seasoned common stock issues following an IPO.

These studies use a number of databases including Compustat, CRSP, Citibank, Extel, DRI and TAQ. The databases are available for research by faculty and students. The studies represent the strong commitment to research and the generation of new knowledge by the Department of Finance, indicative of the department's goal of becoming an outstanding research department.

FINANCE (FIN)**FIN 456 International Financial Management.** (3) A

Exchange rate determination, financial markets, managing multinational corporations, capital budgeting, and hedging currency risk exposure from an international perspective. Prerequisite: professional program business student. Prerequisites with a grade of "C" or higher: ACC 315; FIN 331, 361.

FIN 502 Managerial Finance. (3) A

Theory and practice of financial decision making, including risk analysis, valuation, capital budgeting, cost of capital, and working capital management. Prerequisites: ACC 502; ECN 502; QBA 502.

FIN 521 Investment Management. (3) A

Valuation of equities, fixed incomes, and options/financial futures in an individual security and portfolio context; mathematical asset allocation approaches. Lecture, discussion. Prerequisite: FIN 502.

FIN 527 Derivative Financial Securities. (3) S

Analysis of forwards, futures, and option contracts on bonds, commodities, equities, and foreign exchange. Design of speculative and hedging strategies. Lecture, discussion. Prerequisites: FIN 502, 521.

FIN 531 Capital Markets and Institutions.

(3) A

Recent theoretical and operational developments in economic sectors affecting capital markets and institutions. Lecture, discussion. Prerequisite: FIN 502.

FIN 551 Financial Statement Analysis. (3) A

Analysis of corporations' financial statements to ascertain their financial strength and default risk. Emphasis is on studying cash flows. Lecture, cases. Prerequisites: ACC 502; FIN 502.

FIN 556 International Financial Management. (3) A

Behavior of real and nominal currency exchange rates, management of international investment portfolios, corporate exchange exposure, and hedging exchange risk. Lecture, discussion. Prerequisite: FIN 502.

FIN 561 Financial Management Cases. (3) N

Case-oriented course in applications of finance theory to management issues. Acquisition, allocation, and management of funds within the business enterprise. Working capital management, capital budgeting, capital structure, and financial strategy. Lecture, discussion, presentation. Prerequisite: FIN 502.

FIN 581 Applied Corporate Finance. (3) A

Application of theories in corporate finance. Market efficiency, capital structure, "principal-agent" theory, corporate control, dividend policy, and capital budgeting. Prerequisite: FIN 502.

FIN 781 Theory of Finance. (3) A

Fundamental tools of financial economics; asset pricing, arbitrage, option pricing, capital structure, dividend policy, asymmetric information, and transaction-cost economics. Prerequisites: FIN 502, 521, 531.

FIN 791 Doctoral Seminar in Finance. (3) A

- (a) Financial Institutions and Markets. Economic and monetary theory applied to financial markets and institutions; implications of financial structure for market performance and efficiency. Prerequisite: FIN 581.
- (b) Financial Management. Financial theory pertaining to capital structure, dividend policy, valuation, cost of capital, and capital budgeting. Prerequisite: FIN 581.
- (c) Investments. Investments and market theory; efficient markets hypothesis; option and commodity markets. Prerequisite: FIN 581.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

School of Health Administration and Policy

For faculty, research activity, and courses, refer to "Health Services Administration," pages 214–217.

Department of Management

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BROOKS, CALLARMAN, COOK,
KEATS, KEEFER, KELLER,
MOORHEAD, OLIVAS, OSTROFF,
ROBERSON, D. SMITH-DANIELS,
V. SMITH-DANIELS, VAN HOOK, VERDINI

ASSISTANT PROFESSORS

AMUNDSON, BLANCERO,
BOYD, WISEMAN

SENIOR LECTURERS

CALCATERRA, DORAN,
KREITNER, LEA

MASTER'S DEGREE PROGRAM

The faculty in the Department of Management participate in offering the Technology M.B.A., Executive M.B.A., Evening M.B.A., and Day M.B.A. programs. These programs are administered by the College of Business and are described more fully on pages 61–64. Areas of study offered to Technology, Evening, and Executive M.B.A. students include: process management in high technology organizations; globalization and diversity management; entrepreneurship and small business development; and management consulting.

Ph.D. DEGREE PROGRAM

The faculty in the department offer students the opportunity to obtain a Ph.D. degree in Business Administration with a concentration in management. The doctoral program places primary emphasis on the development of research competence and emphasizes teaching as a vehicle to academic professionalism. The mission of the program is to provide an environment that

is conducive to the development of scholars who are prepared to assume the diverse responsibilities of positions at leading research universities. The goal is to prepare students for research careers in the academic community.

Doctoral students are encouraged to design an individually meaningful course of study within the larger context of the management field. Opportunities for doing this are available through course work, individual work with faculty members, and independent research and study. Students in the Ph.D. program select a series of Ph.D. course modules within the department and several supporting courses from other departments on campus. Students develop additional focus and expertise through collaboration on major papers with individual faculty members.

The faculty in the Department of Management cover the areas of human resource management, management science, operations management, organizational behavior, organizational theory, and strategic management. The faculty's research and teaching emphasizes high tech management, quality, process and project management, decision analysis, globalization, diversity, small business and entrepreneurship, change management, stress, job loss, organizational identity, corporate governance, and human resource management practices. The faculty has distinguished itself with research and publications in premier journals. The department ranks 12th internationally for its rate of publication in premier academic journals. The department also ranks 6th internationally in premier journal articles that impact practice in operations and management science.

Further information, links to courses and current faculty, and updates on the Department of Management areas of study for the M.B.A. programs can be found at www.cob.asu.edu/mgt.

General information on the M.B.A. programs can be found at www.cob.asu.edu/mba.

Further information, application procedures, links to current faculty, and updates on the Ph.D. program in Business with a concentration in management can be found at www.cob.asu.edu/mgt/degree/PhDMainPg.htm.

MANAGEMENT (MGT)

MGT 413 Compensation Management. (3) F, S

Establishing base and incentive pay with job analysis, job evaluation, and wage surveys; performance appraisal; conformance to compensation laws. Prerequisites: MGT 311; professional program business student.

MGT 422 Training and Development. (3) F, S

Learning theory, orientation and basic level training, management development, resource materials and methods. Prerequisites: MGT 311; professional program business student.

MGT 423 Employee-Management Relations. (3) F, S

Employment relationship in union/nonunion setting. Employee-management rights/responsibilities, complaint administration, negotiations, union structure, and mock government negotiations.

MGT 424 Employee Selection and Appraisal. (3) F, S

Concepts and methods of personnel selection and performance appraisal. Includes job analysis, measurement, and legal issues. Experiential exercises emphasized. Prerequisite: MGT 311.

MGT 433 Management Decision Analysis. (3) F, S

Decision-making concepts and methods in the private and public sectors and their application to organizational problems. Understanding of individual and group decision making. Prerequisites: MGT 301; professional program business student.

MGT 434 Social Responsibility of Management. (3) F, S, SS

Relationship of business to the social system and its environment. Criteria for appraising management decisions. Managers as change agents. Prerequisites: MGT 301; professional program business student.

MGT 440 Entrepreneurship. (3) F, S, SS

Opportunities, risks, and problems associated with small business development and operation.

MGT 441 Venture Design and Development. (3) N

Analysis, design, and development of a business plan for a new venture. Prerequisite: ACC 240.

MGT 442 Small Business Management. (3) N

Students, acting as management consultants, apply business principles and make recommendations to small businesses while learning to manage small firms. Prerequisite: business core except MGT 463.

MGT 459 International Management. (3) F, S, SS

Concepts and practices of multinational and foreign firms. Objectives, strategies, policies, and organizational structures for operating in various environments. Prerequisite: MGT 301.

MGT 468 Management Systems. (3) F, S

Systems theory and practice applied to organization process and research. Organizations seen as open systems interacting with changing environments. Prerequisite: MGT 301.

MGT 480 Team Management Skills. (3) F, S

A cooperative education class teaching team skills in active listening, conflict resolution, decision making, effective meetings, norming, and team roles. Cooperative learning.

MGT 494 Special Topics. (3) N

Current topics in management, primarily designed for business majors. See the *Schedule of Classes* for current offerings.

Some of the following may be offered:

- (a) Business Plan Development
- (b) Small Business Planning
- (c) Total Quality Management and Human Resource Management

Note that students may not get credit for both Small Business Planning and Business Plan Development.

MGT 502 Organization Theory and Behavior. (3) A

Important concepts and applications in management, including communication, decision making, group dynamics, leadership, motivation, organization change, and organization design. Prerequisites: computer literacy; graduate degree program student.

MGT 589 Strategic Management. (3) F, S

Formulation of strategy and policy in the organization, emphasizing the integration of decisions in the functional areas. Prerequisite: completion or concurrent enrollment in all other core courses in the M.B.A. program.

MGT 591 Seminar. (3) N

Topics such as the following are offered:

- (a) Business Plan Competition
- (b) Entrepreneurship
- (c) Human Resource Activity and the Management of Diversity
- (d) International Management
- (e) Management Consulting
- (f) Organizational Change and Business Process Consulting

MGT 593 Applied Projects. (3) A

Cross-functional teams initiate (possibly implement) organizational change within a local firm. Lecture, discussion, experiential learning. Prerequisite: completion or concurrent enrollment in all core courses in the M.B.A. program.

MGT 598 Special Topics. (3) N

Graduate special topics chosen from human resources, strategic management, and international management including special topics in international management in Asia or Europe. Prerequisite: instructor approval.

MGT 791 Seminar: Doctoral Seminar in Management. (1) A

Short module seminars such as:

- (a) Causal Modeling
- (b) Change and Coping
- (c) Cognition: Micro and Macro Perspectives
- (d) Economic Theories of the Firm
- (e) Motivation and Attitudes
- (f) Organizational Identity and Identification
- (g) Organizational Learning and Organizational Identity
- (h) Organizational Performance and Reward Systems
- (i) Organizational Strategy and Culture
- (j) Organizational Structure, Technology, and Information Systems
- (k) Organizational Withdrawal
- (l) Performance Appraisal
- (m) Power and Organizational Change
- (n) Selection
- (o) Teams, Groups, and Leadership
- (p) The Craft of Research

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

Department of Marketing

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ASSOCIATE PROFESSORS

BLASKO, SINHA, STEPHENS, WALKER

RESEARCH ACTIVITY

The Department of Marketing has a significant research orientation that spans a broad scope of topics, including strategic marketing management, consumer behavior, selling and sales management, advertising, channels management, international marketing, business to business marketing, and services marketing. Many research projects involve faculty and doctoral student collaboration. Some specific projects published recently have focused on evaluation of service encounters, advertising creativity, relationship quality in selling, channel responsiveness, salesperson motivation, influence patterns in strategic decision making, consumption symbolism, marketing competencies and organizational performance, social network influences on consumer behavior, innovation in industrial markets, and the effects of relationship marketing.

MARKETING (MKT)

MKT 411 Sales Management. (3) N, F, S
Application of management concepts to the administration of the sales operation. Prerequisite: MKT 302.

MKT 412 Promotion Management. (3) A
Integration of the promotional activities of the firm including advertising, personal selling, public relations, and sales promotion. Prerequisite: MKT 302.

MKT 424 Retail Management. (3) A
Role of retailing in marketing. Problems and functions of retail managers within various retail institutions. Prerequisite: MKT 300.

MKT 434 Industrial Marketing. (3) A
Strategies for marketing products and services to industrial, commercial, and governmental markets. Changing industry and market structures. Prerequisite: MKT 302 or instructor approval.

MKT 435 International Marketing. (3) S
Analysis of marketing strategies developed by international firms to enter foreign markets and to adapt to changing international environments. Prerequisites: MKT 302 or instructor approval; professional program business student.

MKT 451 Marketing Research. (3) F, S, SS
Integrated treatment of methods of market research and analysis of market factors affecting decisions in the organization. Prerequisites with a grade of "C" or higher: MKT 302 and QBA 221.

MKT 460 Strategic Marketing. (3) F, S, SS
Policy formulation and decision making by the marketing executive. Integration of marketing programs and consideration of contemporary marketing issues. Prerequisite: professional program business student. Prerequisites with a grade of "C" or higher: MKT 302, 304, 451. *General Studies: L2.*

MKT 502 Marketing Management. (3) F, S, SS
Managing the marketing function; market and environmental analysis; marketing planning, strategy, and control concepts. Development and management of marketing programs. Prerequisite: ECN 502.

MKT 520 Strategic Perspectives of Buyer Behavior. (3) N
Concepts and theories from the behavioral sciences as they relate to marketing strategy formulation. Prerequisite: MKT 502 or equivalent or instructor approval.

MKT 522 Marketing Information. (3) N
Marketing research, marketing information systems, and modern statistical techniques in marketing decision making. Prerequisite: MKT 502.

MKT 524 Services Marketing. (3) A
Strategies for marketing services emphasizing the distinctive challenges and approaches that make marketing of services different from marketing manufactured goods. Prerequisite: MKT 502 or equivalent.

MKT 563 Marketing Strategy. (3) A
Planning and control concepts and methods for developing and evaluating strategic policy from a marketing perspective. Prerequisite: MKT 502.

MKT 591 Seminar. (3) A
Topics such as the following are offered:
(a) Buyer Behavior in Services Environment
(b) Competitive Strategy Services
(c) New Product Development
(d) Customer Satisfaction/Service Quality Measurement
(e) Business-to-Business Marketing
(f) International Marketing

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

Chemical Engineering

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ASSOCIATE PROFESSORS
BECKMAN, BELLAMY, BURROWS,
DEY, GARCIA, RIVERA, TORREST

ASSISTANT PROFESSORS
ALFORD, BEAUDOIN

The faculty in the Department of Chemical, Bio, and Materials Engineering offer graduate programs leading to the M.S., Master of Science in Engineering, and the Ph.D. degrees in Chemical Engineering. Areas of concentration include biomedical and clinical engineering, chemical process engineering, chemical reactor engineering, energy and materials conversion, environmental control, solid-state processing, and transport phenomena. For students interested in the Bioengineering major, see pages 137–139 for program description. Within the Engineering Science major, students may select materials science and engineering as the area of study (see pages 192–193 for program description).

The faculty also participate in offering the interdisciplinary program leading to the Doctor of Philosophy degree with a major in Science and Engineering of Materials (see pages 275–277 for program description). A *Graduate Student Handbook*, detailing information on graduate studies in Chemical Engineering, is available to admitted students. Students should contact the department.

Graduate Record Examination. Graduate Record Examination scores are required from all students.

MASTER OF SCIENCE

See pages 97–99 for information on the M.S. degree.

Transition Program. Students applying for the program leading to a master's degree with a major in Chemical Engineering, or in the area of study of materials science and engineering under the Engineering Science major, may have an undergraduate B.S. degree in a major field other than chemical engineering or materials science. The qualifications of transition students are reviewed by the department graduate committee, and a special program is designed for successful applicants. In general, applicants should have had, or should be prepared to take, calculus through differential equations and physics. Transition students are expected to complete the essential courses in their area of study from the undergraduate program in order to be prepared for the graduate courses. Other course work from the undergraduate program may be required depending upon the area of study selected by the student.

Transition students should contact the graduate coordinator for an evaluation of the undergraduate transcript.

Program of Study. All candidates for the Master of Science in Engineering or M.S. degree in Chemical Engineering, or in the area of study of materials science and engineering under the Engineering Science major, are required to complete an approved program of study consisting of the minimum required semester hours, including research report (M.S.E.) or thesis (M.S.). Special course requirements for the different areas of study are established by the faculty and are available from the departmental graduate coordinator. In addition to the course/thesis requirements, all full-time graduate students must successfully complete the seminar course during each semester of attendance; part-time students must enroll in the seminar course at least three times during the course of study. Candidates whose undergraduate degree was in a field other than chemical engineering or materials science may be required to complete more than 30 semester hours.

Thesis Requirements. A thesis or equivalent is required.

Final Examinations. A final oral examination is required in defense of the thesis or equivalent.

MASTER OF SCIENCE IN ENGINEERING

See page 114 for information on the Master of Science in Engineering degree.

DOCTOR OF PHILOSOPHY

The Ph.D. degree in Chemical Engineering, or in the area of study of materials science and engineering under the Engineering Science major, is conferred upon evidence of excellence in research resulting in a scholarly dissertation that is a contribution to existing knowledge.

See pages 120–122 for general requirements.

Doctoral Program. Upon successful completion of the qualifying examination, a research supervisory committee is formed and the doctoral student is required to submit a research proposal. Following the acceptance of the research proposal, the student is given a comprehensive examination to determine initiative, originality, breadth, and high level of professional commitment to the problem selected for investigation. Upon successful completion of the comprehensive examination, the student applies for admission to candidacy.

Master's Degree in Passing. Students who are enrolled in the Ph.D. degree program in Chemical Engineering, *but who do not hold a previously earned master's degree in chemical engineering*, can obtain the M.S.E. degree (the "Master's in Passing") upon completion of course requirements, the Ph.D. Qualifying Examination, the Dissertation, Prospectus, and the Comprehensive Examination.

As this degree is only available to students who are enrolled as regular students in the Ph.D. program in Chemical Engineering, all of the above requirements (including course work) can be applied toward the Ph.D. requirements.

Foreign Language Requirements. Candidates in the program leading to the Ph.D. degree in Chemical Engineering, or in the area of study materials science and engineering under the Engineering Science major, normally are not required to pass an examination showing reading competency of a for-

ign language. However, the supervisory committee may establish such a requirement in special cases depending upon the research interests of the candidate. If the foreign language is required, the student must successfully fulfill the requirement before taking the comprehensive examination.

Dissertation Requirements. A dissertation based on original work demonstrating creativity in research and scholarly proficiency in the subject area is required.

Final Examinations. A final oral examination in defense of the dissertation is required.

RESEARCH ACTIVITY

Biochemical Engineering. Biochemical separations, biomaterials engineering, scanning probe microscopy, and affinity chromatography.

Biomedical Engineering. Body processes, wearable artificial kidneys, improved blood oxygenators, noninvasive techniques, biophysical property correlations, cardiovascular prosthesis and biomaterials, computer analysis of clinical data, optimization of health delivery systems, biomechanics, biocontrol, analysis of human motion, bioelectronics, medical imaging, and development of physiological sensors.

Chemical Process Control. Advanced process identification and control, continuous process diagnostics, batch supervisory control, statistical process control, expert systems, neural networks, and artificial intelligence. Applications to industrial processes.

Chemical Process Engineering. Chemical process design fundamentals, chemical instrumentation for process control, optimization techniques and applications, process modeling, simulation, dynamics and control, and applied statistics.

Chemical Reactor Engineering. Reactor analysis and design, high temperature reaction kinetics, atmospheric reactions, catalysis, biochemical processes, and semiconductor materials processing.

Energy and Materials Conversion and Conservation. Materials and resource recovery from urban, forest and agricultural wastes, biomass conversion to transportable and conveniently useful

fuels, energy storage, coal gasification, and separation and purification system.

Environmental Analysis and Control. Energy and environmental design considerations, purification of exhaust streams, reduction of emissions from storage tanks, analysis of air and water pollution, modeling of pollution systems, and recycling for pollution control.

Materials Science and Engineering. Semiconductor processing and characterization, polymeric and ceramic composites, materials for high critical temperature superconductor applications, ferritic thin films for capacitor and memory applications, high temperature materials for space applications, mechanical behavior of high strength Al-Li alloys, environmentally influenced mechanical effects, and microbiologically influenced corrosion reactions.

Solid-state Chemistry Concentration. Adsorption, catalysis, solid-state materials processing for control of properties, semiconductor materials processing, chemical vapor deposition, surface reactions, electrochemical reactions, optimization of electroplating processing, and surface analyses.

Transport Processes. Fluid mechanics of small particles, applications of laser Doppler velocimeter, interfacial transport and membrane separations, phase equilibria, and incorporation in process design.

CHEMICAL ENGINEERING (CHE)

CHE 458 Semiconductor Material Processing. (3) N

Introduction to the processing and characterization of electronic materials for semiconductor applications. Prerequisites: CHE 333, 342.

CHE 475 Biochemical Engineering. (3) N

Application of chemical engineering methods, mass transfer, thermodynamics, and transport phenomena to industrial biotechnology. Prerequisite: instructor approval.

CHE 476 Bioreaction Engineering. (3) N

Principles of analysis and design of reactors for processing with cells and other biologically active materials; applications of reaction engineering in biotechnology. Prerequisite: instructor approval.

CHE 477 Bioseparation Processes. (3) N

Principles of separation of biologically active chemicals; the application, scaleup, and design of separation processes in biotechnology. Prerequisite: instructor approval.

CHE 501 Introduction to Transport Phenomena. (3) F, S

Transport phenomena, with emphasis on fluid systems. Prerequisite: transition student with instructor approval.

CHE 502 Introduction to Energy Transport. (3) F, S

Continuation of transport principles, with emphasis on energy transport in stationary and fluid systems. Prerequisite: transition student with instructor approval.

CHE 503 Introduction to Mass Transport. (3) F, S

The application of transport phenomena to mass transfer. The design of mass transfer equipment, including staged processes. Prerequisite: transition student with instructor approval.

CHE 504 Introduction to Chemical Thermodynamics. (3) F, S

Energy relations and equilibrium conversions based on chemical potentials and phase equilibria. Prerequisite: transition student with instructor approval.

CHE 505 Introduction to Chemical Reactor Design. (3) F, S

Application of kinetics to chemical reactor design. Prerequisite: transition student with instructor approval.

CHE 527 Advanced Applied Mathematical Analysis in Chemical Engineering. (3) F

Formulation and solution of complex mathematical relationships resulting from the description of physical problems in mass, energy, and momentum transfer and chemical kinetics.

CHE 528 Process Optimization Techniques. (3) S

Method for optimizing engineering processes. Experimental design and analysis; linear and nonlinear regression methods; classical, search, and dynamic programming algorithms.

CHE 533 Transport Processes I. (3) F

Unified treatment of momentum, heat, and mass transfer from molecular theory, and continuum points of view. Continuum equations of microscopic and macroscopic systems and multicomponent and multiphase systems. Cross-listed as BME 533.

CHE 534 Transport Processes II. (3) S

Continuation of CHE/BME 533, emphasizing mass transfer. Cross-listed as BME 534. Prerequisite: BME/CHE 533.

CHE 536 Convective Mass Transfer. (3) N

Turbulent flow for multicomponent systems, including chemical reactions with applications in separations and air pollution. Prerequisite: CHE 533 or MAE 571.

CHE 543 Thermodynamics of Chemical Systems. (3) F

Classical and statistical thermodynamics of nonideal physicochemical systems and processes; prediction of optimum operating conditions. Cross-listed as BME 543.

CHE 544 Chemical Reactor Engineering. (3) S

Reaction rates, thermodynamics, and transport principles applied to the design and operation of chemical reactors. Cross-listed as BME 544. Prerequisite: BME/CHE 543.

CHE 548 Topics in Catalysis. (3) N

Engineering catalysis, emphasizing adsorption, kinetics, characterization, diffusional considerations, and reactor design. Other topics include mechanisms, surface analyses, and electronic structure.

CHE 552 Industrial Water Quality Engineering. (3) N

Water pollutants, quality criteria and control, chemical treatment processing, and system design. Case studies. Prerequisite: CHE 331 or equivalent.

CHE 553 Air Quality Control. (3) N

Air pollutant origins, effects, and control. Physical and chemical processes, including dispersion, combustion, sampling, control equipment design, and special topics. Prerequisite: CHE 331 or equivalent.

CHE 554 New Energy Technology. (3) N

Gasification, liquefaction pyrolysis, and combustion processes for coal, wastes, and other raw materials. In-situ processes for coal, oil, shale, and geothermal energy. Environmental quality issues.

CHE 556 Separation Processes. (3) N

Topics in binary/multicomponent separation, rate governed and equilibration processes, mass transfer criteria, energy requirements, separating agents and devices, and staged operations.

CHE 558 Electronic Materials. (3) N

Processing and characterization of electronic materials for semiconductor type uses. Thermodynamics and transport phenomena, phase equilibria and structure, mass transfer, and diffusion and thermal properties.

CHE 561 Advanced Process Control. (3) S

Dynamic process representation, linear optimal control, optimal state reconstruction, and parameter and state estimation techniques for continuous and discrete time systems.

CHE 563 Chemical Engineering Design. (3) N

Computational methods; the design of chemical plants and processes.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.

MATERIALS SCIENCE AND ENGINEERING (MSE)

MSE 421 Physical Metallurgy Laboratory.

(1) S
Focuses on analysis of microstructure of metals and alloys and includes correlation with mechanical properties to some extent. Lab. Pre- or corequisite: MSE 420.

MSE 453 Experiments in Materials Synthesis and Processing II. (2) F

A continuation of MSE 354, with emphasis on characterization. Small groups complete three experiments supervised by selected faculty members. Lab. Prerequisites: MSE 353 and 354 or equivalents.

MSE 454 Advanced Materials Processing and Synthesis. (3) S

Case studies from published literature of current techniques in materials processing and synthesis. Student participation in classroom presentations. Lecture, recitation. Prerequisites: MSE 353 and 354 or equivalents.

MSE 510 X-ray and Electron Diffraction. (3) F

Fundamentals of X-ray diffraction, transmission electron microscopy, and scanning electron microscopy. Techniques for studying surfaces, internal microstructures, and fluorescence. Lecture, demonstrations. Prerequisite: transition student with instructor approval.

MSE 511 Corrosion and Corrosion Control. (3) S

Introduction to corrosion mechanisms and methods of preventing corrosion. Topics include the following: electrochemistry, polarization, corrosion rates, oxidation, coatings, and cathodic protection. Prerequisite: transition student with instructor approval.

MSE 512 Analysis of Material Failures. (3) S

Identification of types of failures. Analytical techniques. Fractography, SEM, nondestructive inspection, and metallography. Mechanical and electronic components. Prerequisite: transition student with instructor approval.

MSE 513 Polymers and Composites. (3) F

Relationship between chemistry, structure, and properties of engineering polymers. Design, properties, and behavior of fiber composite systems.

MSE 514 Physical Metallurgy. (4) F

Crystal structure and defects. Phase diagrams, metallography, solidification and casting, and deformation and annealing. Lecture, lab. Prerequisite: transition student with instructor approval.

MSE 515 Thermodynamics of Materials. (3) N

Principles of statistical mechanics, statistical thermodynamics of single crystals, solutions, phase equilibrium, free energy of reactions, free electron theory, and thermodynamics of defects. Prerequisite: transition student with instructor approval.

MSE 516 Mechanical Properties of Solids. (3) S

Effects of environmental and microstructural variables of mechanical properties, including plastic deformation, fatigue, creep, brittle fracture, and internal friction. Prerequisite: transition student with instructor approval.

MSE 517 Introduction to Ceramics. (3) F

Principles of structure, property relations in ceramic materials. Processing techniques. Applications in mechanical, electronic, and superconducting systems. Prerequisite: transition student with instructor approval.

MSE 518 Integrated Circuits Materials Science. (3) N

Principles of materials science applied to semiconductor processing and fabrication in metals, ceramics, polymers, and semiconductors. Prerequisite: transition student with instructor approval.

MSE 520 Theory of Crystalline Solids. (3) F

Anisotropic properties of crystals; tensor treatment of elastic, magnetic, electric and thermal properties, and crystallography of Martensitic transformations.

MSE 521 Defects in Crystalline Solids. (3) S

Introduction to the geometry, interaction, and equilibrium between dislocations and point defects. Relations between defects and properties will be discussed. Prerequisite: ECE 350 or instructor approval.

MSE 530 Materials Thermodynamics and Kinetics. (3) S

Thermodynamics of alloy systems, diffusion in solids, kinetics of precipitation, and phase transformations in solids. Prerequisites: ECE 340, 350.

MSE 540 Fracture, Fatigue, and Creep. (3) F

Relationship between microstructure and fracture; fatigue and creep properties of materials. Environmental effects and recent developments. Current theories and experimental results. Prerequisite: MSE 440 or equivalent.

MSE 550 Advanced Materials Characterization. (3) N

Analytical instrumentation for characterization of materials; SEM, SIMS, Auger, analytical TEM, and other advanced research techniques.

MSE 556 Electron Microscopy Laboratory. (3) F

Lab support for MSE 558. Cross-listed as SEM 556. Pre- or corequisite: MSE/SEM 558.

MSE 557 Electron Microscopy Laboratory. (3) S

Lab support for MSE 559. Cross-listed as SEM 557. Pre- or corequisite: MSE/SEM 559.

MSE 558 Electron Microscopy I. (3) F

Microanalysis of the structure and composition of materials using images, diffraction and X-ray, and energy loss spectroscopy. Knowledge of elementary crystallography, reciprocal lattice, stereographic projections, and complex variables is required. Cross-listed as SEM 558. Prerequisite: instructor approval.

MSE 559 Electron Microscopy II. (3) S

Microanalysis of the structure and composition of materials using images, diffraction and X-ray, and energy loss spectroscopy. Knowledge of elementary crystallography, reciprocal lattice, stereographic projections, and complex variables is required. Cross-listed as SEM 559. Prerequisite: instructor approval.

MSE 560 Strengthening Mechanisms. (3) S

Deformation of crystalline materials. Properties of dislocations. Theories of strain hardening, solid solution, precipitation, and transformation strengthening. Prerequisite: ECE 350 or equivalent.

MSE 561 Phase Transformation in Solids. (3) N

Heterogeneous and homogeneous precipitation reactions, shear displacive reactions, and order-disorder transformation.

MSE 562 Ion Implantation. (3) S

Includes defect production and annealing. Generalized treatment, including ion implantation, neutron irradiation damage, and the interaction of other incident beams. Prerequisite: MSE 450.

MSE 570 Polymer Structure and Properties. (3) F

Relationships between structure and properties of synthetic polymers, including glass transition, molecular relaxations, crystalline state viscoelasticity, morphological characterization, and processing.

MSE 571 Ceramics. (3) A

Includes ceramic processing, casting, molding, firing, sintering, crystal defects, and mechanical, electronic, and physical properties. Prerequisites: MSE 521, 561.

MSE 573 Magnetic Materials. (3) A

Emphasis on ferromagnetic and ferrimagnetic phenomena. Domains, magnetic anisotropy, and magnetostriction. Study of commercial magnetic materials. Prerequisite: MSE 520 or equivalent.

Omnibus Graduate Courses: See pages 51–52 for omnibus graduate courses that may be offered.