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# Mechanical Engineering

## Master's and Doctoral Programs

[www.eas.asu.edu/~mac](http://www.eas.asu.edu/~mac)

480/965-3291

ECG 346

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**Robert E. Peck, Chair**

**Professors:** Boyer, Davidson, Evans, Fernando, Jankowski, Krajcinovic, Peck, Roy, Shah, Sieradzki, Tseng, Yao

**Associate Professors:** Chen, Kuo, Phelan, Squires

**Assistant Professors:** Calhoun, Chapsky, McNeill, Peralta, Sugar

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The faculty in the Department of Mechanical and Aerospace Engineering offer graduate programs leading to the degrees of M.S., M.S.E., and Ph.D. in Mechanical Engineering. A number of areas of study may be pursued, including design and manufacturing, dynamics and control, energy systems, engineering mechanics, and thermosciences.



Many areas on campus accommodate wireless computer connections.

Tim Trumble photo

The faculty also offer graduate degree programs in Aerospace Engineering.

All of the department's graduate programs stress a sound foundation in fundamentals 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 "Master's Degrees," page 93, for general requirements.

### MASTER OF SCIENCE IN ENGINEERING

See "Master of Science in Engineering," page 196, for information on the Master of Science in Engineering degree.

### MASTER OF ENGINEERING

The faculty also participate in offering the tri-university Master of Engineering program. See "Master of Engineering," page 190.

### 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 mechanical engineering.

See "Doctoral Dissertations," page 95, 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 qualified 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, a graduate student pursuing a Ph.D. program of study in Mechanical Engineering must complete three 500-level core courses, preferably in the major area of interest, and one 500-level mathematics course, both with an average GPA of 3.25 or higher. 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 of Mechanical and Aerospace Engineering is organized informally into four disciplinary research groups. The Design Automation Lab of the Design and Manufacturing Group engages in research and education related to the planning and manufacture of mechanical and aerospace engineering products. Research projects include CAD/CAM; geometric modeling; process planning; knowledge-based systems; design theory; engineering data management; creativity techniques; machine intelligence; computational techniques; and engineering analysis. This group is also involved in the development of models for geometric tolerances and dimensioning, a collaboration with the Department of Psychology to develop models for human pursuit strategies, and the design and development of systems of robots.

The Fluid Dynamics and Aerodynamics Group conducts numerical analyses on the modeling of particle-laden turbulent flows; development and assessment of methods for predicting high Reynolds number separated flows; simulation and modeling of the flow and thermal fields in gas-turbine vane-endwall passages; large-eddy simulations; wall-layer modeling of complex boundary layers; boundary-layer transition and flow control; hypersonics; micro-propulsion; and low-chord-Reynolds-number aerodynamics. Theoretical work is carried out on multi-phase and multi-component flows, hydrodynamic stability, polymeric materials processing and fluid behavior in micro-machined systems. Numerical and laboratory modeling and theoretical approaches are used to apply the basic principles of fluid dynamics to geophysical and environmental flows, such as air pollution dispersion, turbulence in the oceans and atmosphere, and topography effects on atmospheric and oceanic currents. Detailed experimental research is conducted on transition and flow control of 2-D and 3-D boundary layers, flow fields measurements and drag reduction on micro-aerial vehicles, and vortex generation in time dependent internal flows. The department faculty are also closely involved in low-cost space experimentation and satellite design.

Members of the Thermodynamics and Heat Transfer Group are investigating cryogenic heat transfer, including thermal contact resistance and mesoscale cryo-cooler development; energy systems engineering, including energy efficiency of manufacturing facilities and commercial buildings, refrigeration, and indoor air quality; nanoscale and microscale transport processes, using biomolecular motors; FT-IR spectroscopy for gas and other material characterization; turbulent combustion; remote monitoring of pollutants; gas-turbine/spray combustion; fuel systems safety; combustion in porous media; emission control; thermal systems design/optimization; experiments and modeling of multi-phase flow and thermal fields; experiments and simulation of flow and heat transfer in gas turbine components; and thermodynamic analysis of combined-cycle power plants.

Research in the Dynamics and Solid Mechanics Group includes the determination of the forced response of turbomachinery blades, including defects (mistuning), as well as the optimization of the blade properties; vibration testing for sensor optimization; the determination of the random response and fatigue life of thermally buckled panels sub-

jected to a transverse acoustic excitation; the assessment/optimization of a flutter exciter, the nonlinear dynamic response of structural systems (e.g., aircraft) stabilized by internal friction; the vibration monitoring of power plant components; the integrated orbit, attitude, and structural control design for large spacecraft; rapid multi-target pointing control of agile spacecraft using control moment gyros and singularity analysis for redundant single-gimbal control moment gyros. This group also has a strong research effort on the modeling, analysis and design synthesis of composite structures, smart materials and integrated systems; application areas include vibration, noise and shape control, and structural health monitoring. Research in mechanics of materials includes the understanding of brittle behavior in ductile metals; the stress-corrosion cracking problem using the molecular dynamic technique; corrosion and passivation in alloys; fracture of solids with random porosity; elastic properties of superlattices; and thin-film growth to demonstrate that local surface defect interactions control global film morphology. Studies are also conducted in kinematics of fatigue crack propagation, indentation mechanics of monocrystalline substrates, and deformation and fracture of alloyed molybdenum silicides.

## Computer Resources and Facilities

Mechanical Engineering graduate education and research is supported by an extensive array of college- and university-supported computer hardware and software, in addition to laboratory workstations.

CEAS Engineering Technical Services (ETS) provides a significant amount of computer equipment, hardware engineering staff, and system staff dedicated to supporting research activities within the college. The central computers, PCs, and distributed workstations in offices and laboratories in the Engineering Research Center (ERC), Barry Goldwater Center (GWC), and many adjoining engineering buildings all link together to form the Engineering Network Support System (ENSS). ENSS utilizes the standard TCP/IP protocol on an ethernet local area network. Faculty and labs connect their PCs directly to ENSS via ethernet. Ethernet is offered in two speeds: 10 mbs and 100 mbs. Central computers accessible via ENSS include these distributed systems:

1. 300 to 400 Unix workstations (Sun, Silicon Graphics, DEC, HP, IBM, Intel);
2. 2500 to 3000 PCs running mostly Windows NT;
3. 13 to 15 Novell PC LANs ultimately being converted to Windows NT LANs or re-centralized; and
4. 8 to 10 Windows NT LANs, many of which are being re-centralized.

## MECHANICAL AND AEROSPACE ENGINEERING (MAE)

### MAE 402 Introduction to Continuum Mechanics. (3)

*once a year*

Applies the principles of continuum mechanics to such fields as flow-in porous media, biomechanics, electromagnetic continua, and magneto-fluid mechanics. Prerequisites: ECE 313; MAE 361 (or 371); MAT 242 (or 342).

## GRADUATE PROGRAMS AND COURSES

### **MAE 404 Finite Elements in Engineering. (3)**

*once a year*

Introduces ideas and methodology of finite element analysis. Applications to solid mechanics, heat transfer, fluid mechanics, and vibrations. Prerequisites: ECE 313; MAT 242 (or 342).

### **MAE 406 CAD/CAM Applications in MAE. (4)**

*once a year*

Solution of engineering problems with the aid of state-of-the-art software tools in solid modeling, engineering analysis, and manufacturing; selection of modeling parameters; reliability tests on software. 3 hours lecture, 3 hours lab. Prerequisites: ECE 384; MAE 422, 441 (or 444).

### **MAE 415 Vibration Analysis. (4)**

*fall*

Free and forced response of single and multiple degree of freedom systems, continuous systems; applications in mechanical and aerospace systems numerical methods. Lecture, lab. Prerequisites: ECE 212; MAE 319, 422 (or 425); MAT 242 (or 342).

### **MAE 417 Control System Design. (3)**

*once a year*

Tools and methods of control system design and compensation, including simulation, response optimization, frequency domain techniques, state variable feedback, and sensitivity analysis. Introduces nonlinear and discrete time systems. Prerequisite: MAE 317.

### **MAE 433 Air Conditioning and Refrigeration. (3)**

*once a year*

Air conditioning processes; environmental control; heating and cooling loads; psychrometry; refrigeration cycles. Prerequisite: MAE 388 or MET 432 or instructor approval.

### **MAE 434 Internal Combustion Engines. (3)**

*once a year*

Performance characteristics, combustion, carburetion and fuel-injection, and the cooling and control of internal combustion engines. Computer modeling. Lab. Prerequisite: MAE 388.

### **MAE 435 Turbomachinery. (3)**

*once a year*

Design and performance of turbomachines, including steam, gas and hydraulic turbines, centrifugal pumps, compressors, fans, and blowers. Pre- or corequisite: MAE 361 or 371.

### **MAE 436 Combustion. (3)**

*once a year*

Thermochemical and reaction rate processes; combustion of gaseous and condensed-phase fuels. Applications to propulsion and heating systems. Pollutant formation. Prerequisite: MAE 388.

### **MAE 442 Mechanical Systems Design. (4)**

*spring*

Applies design principles and techniques to the synthesis, modeling, and optimization of mechanical, electromechanical, and hydraulic systems. Prerequisites: MAE 317, 441 (or 444).

### **MAE 446 Thermal Systems Design. (3)**

*once a year*

Applies engineering principles and techniques to the modeling and analysis of thermal systems and components. Presents and demonstrates optimization techniques and their use. Prerequisite: ECE 300; MAE 388.

### **MAE 447 Robotics and Its Influence on Design. (3)**

*once a year*

Robot applications, configurations, singular positions, and work space; modes of control; vision; programming exercises; design of parts for assembly. Prerequisite: MAE 317.

### **MAE 455 Polymers and Composites. (3)**

*fall*

Relationship between chemistry, structure, and properties of engineering polymers. Design, properties, and behavior of fiber composite systems. Cross-listed as MSE 470. Credit is allowed for only MAE 455 or MSE 470. Prerequisites: ECE 313, 350.

### **MAE 460 Gas Dynamics. (3)**

*spring*

Compressible flow at subsonic and supersonic speeds; duct flow; normal and oblique shocks, perturbation theory, and wind tunnel design. Prerequisites: ECE 384; MAE 361 (or 371).

### **MAE 462 Space Vehicle Dynamics and Control. (3)**

*fall*

Attitude dynamics and control, launch vehicles, orbital mechanics, orbital transfer/rendezvous, space mission design, space structures, spacecraft control systems design. Prerequisite: MAE 317.

### **MAE 463 Propulsion. (3)**

*fall*

Fundamentals of gas-turbine engines and design of components. Principles and design of rocket propulsion and alternative devices. Lecture, design projects. Prerequisites: ECE 384; MAE 382 (or 460).

### **MAE 465 Rocket Propulsion. (3)**

*once a year*

Rocket flight performance; nozzle design; combustion of liquid and solid propellants; component design; advanced propulsion systems; interplanetary missions; testing. Prerequisite: MAE 382 or 460.

### **MAE 466 Rotary Wing Aerodynamics and Performance. (3)**

*once a year*

Introduces helicopter and propeller analysis techniques. Momentum, blade-element, and vortex methods. Hover and forward flight. Ground effect, autorotation, and compressibility effects. Prerequisites: both ECE 384 and MAE 361 or only instructor approval.

### **MAE 467 Aircraft Performance. (3)**

*once a year*

Integrates aerodynamic and propulsive forces into aircraft performance design. Estimation of drag parameters for design. Engine, airfoil selection. Conceptual design methodology. Lecture, design projects. Prerequisite: MAE 361 or 371. Pre- or corequisite: MAE 444.

### **MAE 469 Projects in Astronautics or Aeronautics. (3)**

*fall and spring*

Various multidisciplinary team projects available each semester. Projects include design of high-speed rotocraft autonomous vehicles, liquid-fueled rockets, microaerial vehicles, satellites. Prerequisite: instructor approval.

### **MAE 471 Computational Fluid Dynamics. (3)**

*once a year*

Numerical solutions for selected problems in fluid mechanics. Prerequisites: ECE 384; MAE 361 (or 371).

### **MAE 504 Laser Diagnostics. (3)**

*spring*

Fundamentals of optics and the interaction of light with matter. Laser sources, laser spectroscopy, velocimetry, particle sizing, and surface characterization.

### **MAE 505 Perturbation Methods. (3)**

*selected semesters*

Nonlinear oscillations, strained coordinates, renormalization, multiple scales, boundary layers, matched asymptotic expansions, turning point problems, and WKBJ method. Cross-listed as MAT 505. Credit is allowed for only MAE 505 or MAT 505.

### **MAE 506 Advanced System Modeling, Dynamics, and Control. (3)**

*spring*

Lumped-parameter modeling of physical systems with examples. State variable representations and dynamic response. Introduces modern control. Prerequisite: ASE 582 or MAT 442.

### **MAE 507 Optimal Control. (3)**

*fall*

Optimal control of systems. Calculus of variations, dynamic programming, linear quadratic regulator, numerical methods, and Pontryagin's principle. Cross-listed as EEE 587. Credit is allowed for only EEE 587 or MAE 507. Prerequisite: EEE 482 or MAE 506.

### **MAE 509 Robust Multivariable Control. (3)**

*spring*

Characterization of uncertainty in feedback systems, robustness analysis, synthesis techniques, multivariable Nyquist criteria, computer-aided analysis and design. Prerequisites: MAE 417, 506.

### **MAE 510 Dynamics and Vibrations. (3)**

*fall*

Lagrange's and Hamilton's equations, rigid body dynamics, gyroscopic motion, and small oscillation theory.

### **MAE 511 Acoustics. (3)**

*fall*

Principles underlying the generation, transmission, and reception of acoustic waves. Applications to noise control, architectural acoustics, random vibrations, and acoustic fatigue.

**MAE 512 Random Vibrations. (3)***spring*

Reviews probability theory, random processes, stationarity, power spectrum, white noise process, random response of single and multiple DOF systems, and Markov processes simulation. Prerequisite: MAE 510 or instructor approval.

**MAE 515 Structural Dynamics. (3)***spring*

Free vibration and forced response of discrete and continuous systems, exact and approximate methods of solution, finite element modeling, and computational techniques. Prerequisite: MAE 510 or instructor approval.

**MAE 518 Dynamics of Rotor-Bearing Systems. (3)***spring*

Natural whirl frequency, critical speed, and response analysis of rigid and flexible rotor systems. Bearing influence and representation. Stability analysis. Methods of balancing.

**MAE 520 Solid Mechanics. (3)***fall*

Introduces tensors: kinematics, kinetics, and constitutive assumptions leading to elastic, plastic, and viscoelastic behavior. Applications.

**MAE 521 Structural Optimization. (3)***selected semesters*

Linear and nonlinear programming. Problem formulation. Constrained and unconstrained optimization. Sensitivity analysis. Approximate techniques. FEM-based optimal design of mechanical and aerospace structures. Cross-listed as CEE 533. Credit is allowed for only CEE 533 or MAE 521. Prerequisite: instructor approval.

**MAE 523 Theory of Plates and Shells. (3)***fall*

Linear and nonlinear theories of plates. Membrane and bending theories of shells. Shells of revolution. Prerequisite: MAE 520.

**MAE 524 Theory of Elasticity. (3)***spring*

Elastic behavior in two and three dimensions. Airy stress functions and displacement potentials. Elements of fracture. Prerequisite: MAE 520.

**MAE 527 Finite Element Methods in Engineering Science. (3)***fall*

Discretization, interpolation, elemental matrices, assembly, and computer implementation. Application to solid and fluid mechanics, heat transfer, and time-dependent problems. Prerequisite: ASE 582.

**MAE 536 Combustion. (3)***selected semesters*

Thermodynamics; chemical kinetics of combustion. Explosion and ignition theories. Reactive gas dynamics. Structure, propagation, and stability of flames. Experimental methods. Prerequisite: MAE 436 or instructor approval.

**MAE 540 Advances in Engineering Design Theory. (3)***fall*

Survey of research in engineering design process, artifact and design, knowledge, formal and informal logic, heuristic and numerical searches, theory of structure and complexity. Prerequisite: graduate standing.

**MAE 541 CAD Tools for Engineers. (3)***fall*

Elements of computer techniques required to develop CAD software. Data structures, including lists, trees, and graphs. Computer graphics, including 2- and 3-dimensional algorithms and user interface techniques.

**MAE 544 Mechanical Design and Failure Prevention. (3)***fall*

Modes of mechanical failure; applies principles of elasticity and plasticity in multiaxial state of stress to design synthesis; failure theories; fatigue; creep; impact. Prerequisite: MAE 443.

**MAE 546 CAD/CAM Applications in MAE. (4)***once a year*

Solution of engineering problems with the aid of state-of-the-art software tools in solid modeling, engineering analysis, and manufacturing; selection of modeling parameters; reliability tests on software. Open only to students without previous credit for MAE 406. 3 hours lecture, 3 hours lab. Prerequisites: ECE 384; MAE 422, 441 (or 444).

**MAE 547 Mechanical Design and Control of Robots. (3)***selected semesters*

Homogeneous transformations, 3-dimensional kinematics, geometry of motion, forward and inverse kinematics, workspace and motion trajectories, dynamics, control, and static forces.

**MAE 548 Mechanism Synthesis and Analysis. (3)***spring*

Algebraic and graphical methods for exact and approximate synthesis of cam, gear, and linkage mechanisms; design optimization; methods of planar motion analysis; characteristics of plane motion; spatial kinematics.

**MAE 557 Mechanics of Composite Materials. (3)***spring*

Analyzes composite materials and applications. Micromechanical and macromechanical behavior. Classical lamination theory developed with investigation of bending-extension coupling.

**MAE 560 Propulsion Systems. (3)***selected semesters*

Design of air-breathing gas turbine engines for aircraft propulsion; mission analysis; cycle analysis; engine sizing; component design.

**MAE 561 Computational Fluid Dynamics. (3)***spring*

Finite-difference and finite-volume techniques for solving the subsonic, transonic, and supersonic flow equations. Method of characteristics. Numerical grid-generation techniques. Prerequisite: MAE 571 or instructor approval.

**MAE 563 Unsteady Aerodynamics. (3)***spring*

Unsteady incompressible and compressible flow. Wings and bodies in oscillatory and transient motions. Kernel function approach and panel methods. Aeroelastic applications. Prerequisite: MAE 460 or 461.

**MAE 564 Advanced Aerodynamics. (3)***fall*

Perturbation method. Linearized subsonic and supersonic flows. Thin wing/slender body theories. Lifting surface theory. Panel method computation. Prerequisite: MAE 460 or 461.

**MAE 566 Rotary-Wing Aerodynamics. (3)***fall*

Introduces helicopter and propeller analysis techniques. Momentum, blade-element, and vortex methods. Hover and forward flight. Ground effect, autorotation, and compressibility effects. Prerequisite: MAE 361.

**MAE 571 Fluid Mechanics. (3)***fall*

Basic kinematic, dynamic, and thermodynamic equations of the fluid continuum and their application to basic fluid models.

**MAE 572 Inviscid Fluid Flow. (3)***spring*

Mechanics of fluids for flows in which the effects of viscosity may be ignored. Potential flow theory, waves, and inviscid compressible flows. Prerequisite: MAE 571.

**MAE 573 Viscous Fluid Flow. (3)***fall*

Mechanics of fluids for flows in which the effects of viscosity are significant. Exact and approximate solutions of the Navier-Stokes system, laminar flow at low and high Reynolds number. Prerequisite: MAE 571.

**MAE 575 Turbulent Shear Flows. (3)***fall*

Homogeneous, isotropic, and wall turbulence. Experimental results. Introduces turbulent-flow calculations. Prerequisite: MAE 571.

**MAE 577 Turbulent Flow Modeling. (3)***spring*

Reynolds equations and their closure. Modeling of simple and complex turbulent flows, calculations of internal and external flows, and application to engineering problems. Prerequisite: MAE 571.

**MAE 581 Thermodynamics. (3)***fall*

Basic concepts and laws of classical equilibrium thermodynamics; applications to engineering systems. Introduces statistical thermodynamics.

## GRADUATE PROGRAMS AND COURSES

### **MAE 582 Statistical Thermodynamics. (3)**

*once a year*

Kinetic and quantum theory. Statistical mechanics; ensemble theory. Structure and thermodynamics of noninteracting and interacting particles. Boltzmann integro-differential equation. Prerequisite: graduate standing.

### **MAE 585 Conduction Heat Transfer. (3)**

*fall*

Basic equations and concepts of conduction heat transfer. Mathematical formulation and solution (analytical and numerical) of steady and unsteady, one- and multidimensional heat conduction and phase change problems. Prerequisites: ECE 384; MAE 388.

### **MAE 586 Convection Heat Transfer. (3)**

*spring*

Basic concepts and governing equations. Analyzes laminar and turbulent heat transfer for internal and external flows. Natural and mixed convection. Prerequisite: MAE 388.

### **MAE 587 Radiation Heat Transfer. (3)**

*fall*

Advanced concepts and solution methodologies for radiation heat transfer, including exchange of thermal radiation between surfaces, radiation in absorbing, emitting, and scattering media and radiation combined with conduction and convection. Prerequisite: MAE 388.

### **MAE 588 Two-Phase Flows and Boiling Heat Transfer. (3)**

*spring*

Pool and flow boiling heat transfer, condensation heat transfer, various models of vapor-liquid mixture flows, gas-solid mixture flows, and experimental measurement techniques.

### **MAE 589 Heat Transfer. (3)**

*fall*

Basic concepts; physical and mathematical models for heat transfer. Applications to conductive, convective, radiative, and combined mode heat transfer. Prerequisite: MAE 388.

### **MAE 594 Graduate Research Conference. (1)**

*fall and spring*

Topics in contemporary research. Required every semester of all departmental graduate students registered for 9 or more semester hours. Not for degree credit.

### **MAE 598 Special Topics. (1-4)**

*fall and spring*

Special topics courses, including the following, which are regularly offered, are open to qualified students. Topics may include the following:

- Advanced Spacecraft Control. (1-3)
- Aeroelasticity. (1-3)
- Aerospace Vehicle Guidance and Control. (1-3)
- Boundary Layer Stability. (1-3)
- Hydrodynamic Stability. (1-3)
- Plasticity. (1-3)
- Polymers and Composites. (1-3)

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

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## Medieval and Renaissance Studies

### Interdisciplinary Certificate Programs

[www.asu.edu/clas/acmrs/cert.html](http://www.asu.edu/clas/acmrs/cert.html)

480/965-5900

SS 224

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Robert E. Bjork, Director

### **American Studies (ASU West)**

Associate Professor: Moulton

### **Architecture**

Professor: Meunier

Assistant Professor: Caicco

### **Art**

Associate Professors: Schleif, Wolfthal

### **Barrett Honors College**

Senior Lecturer: Facinelli

### **English**

Professors: Bjork, Brink, Gutierrez

Associate Professors: Corse, Mahoney, Perry, Voaden

Assistant Professor: Fox

### **History**

Professors: Batalden, Burg, Green, Tillman, Warnicke

Associate Professors: Barnes, Soergel, Thornton

Assistant Professor: Koopmans

### **Languages and Literatures**

Professors: Alexander, Losse, Wixted

Associate Professors: Candela, Hendrickson, Sanchez, Senner, Vitullo

Assistant Professor: George

### **Law**

Professors: Brennan, Rose

### **Music**

Professor: Metz

Associate Professor: Haefer

### **Philosophy**

Professor: White

### **Religious Studies**

Professor: Coudert

Associate Professor: Clay

### **Theatre**

Professor: Knapp

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Graduate students admitted to a degree program in any field may earn one of two M.A.- or Ph.D.-level certificates:

the Certificate in Medieval Studies or the Certificate in Renaissance Studies. Since medieval and Renaissance studies are by nature interdisciplinary, students in the certificate program receive interdisciplinary training. Besides the course work and examinations required in their major field, students take six to nine semester hours outside their discipline and receive training in a medieval vernacular language or a modern European language.

The core of the program has two components: (1) Latin, the international language for both the Middle Ages and Renaissance, and (2) paleography, the study of the physical medium through which Latin and other languages were transmitted.

The certificate program prepares students for advanced study or for academic positions by augmenting their skills and knowledge, thereby making them more equipped to handle the demands of their fields. For more information, contact the Arizona Center for Medieval and Renaissance Studies.

### COURSES

*For course information, contact the Arizona Center for Medieval and Renaissance Studies.*

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## Microbiology

### Master's and Doctoral Programs

[ls.la.asu.edu/microbiology/text/grad.htm](http://ls.la.asu.edu/microbiology/text/grad.htm)

480/965-1457

LSE 210

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### Edward A. Birge, Chair

**Professors:** Burke, Jacobs, Misra, Mossman, Schmidt

**Associate Professors:** Birge, Hoffman, Hogue, Stout

**Assistant Professors:** Chang, Garcia-Pichel

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The faculty in the Department of Microbiology offer programs leading to the M.S. and the Ph.D. degrees in Microbiology.

The faculty also participate in the program leading to the Master of Natural Science degree when one of the concentrations is microbiology (see "Natural Science," page 279).

The Graduate Record Examination (GRE) is required for all applicants. Three letters of recommendation and a statement of personal goals must be submitted for admission to the graduate programs. Applicants are expected to have completed the requirements for an undergraduate major in Biology, Chemistry, or Microbiology or have an adequate background in related courses in biology, chemistry, mathematics, physics, and plant biology. Applicants without this background may be asked to take the GRE subject test. Applications are accepted throughout the year. To be considered for assistantships and fellowships, completed appli-

cations must be received by February 15 for the fall semester and by October 15 for the spring semester.

The graduate programs are designed to prepare students for careers in teaching and in research on various aspects of microbiology in educational institutions, industry, or government agencies. To ensure proper course selection, new students must have the department's approval for all course registrations.

### MASTER OF SCIENCE

See "Master's Degrees," page 93, for general requirements.

**Program of Study.** A minimum of 30 semester hours of graduate credit are required, of which at least six hours must be thesis and research credit. The program is planned by the student in consultation with the supervisory committee.

**Foreign Language Requirements.** None.

**Comprehensive Examinations.** Students are expected to achieve, through course work, a fundamental understanding of the following subdisciplines: bacterial genetics, immunology, molecular biology, physiology and metabolism, and virology. Alternatively, the student may demonstrate this fundamental understanding by a comprehensive examination prepared by the student's supervisory committee.

**Thesis Requirements.** A thesis is required.

**Final Examinations.** A final oral examination covering the thesis and related subject matter is required.

### DOCTOR OF PHILOSOPHY

See "Doctor of Philosophy," page 96, for general requirements.

**Program of Study.** At least 60 semester hours of graduate credit, in addition to 24 hours of dissertation and research, are required; a minimum of 24 hours of this total is in formal course work. The program is planned in consultation with the supervisory committee.

**Foreign Language Requirements.** None.

**Comprehensive Examinations.** Written and oral comprehensive examinations are required.

**Dissertation Requirements.** A dissertation based on original work of high quality, demonstrating proficiency in the student's area of interest, is required. (See "Doctoral Dissertations," page 95.)

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

### MICROBIOLOGY (MIC)

#### MIC 420 Immunology: Molecular and Cellular Foundations. (3)

*fall*

Molecular and cellular foundations of immunology. Antibody/antigen interactions, cellular response, cytokines, immunogenetics, immunoregulation, autoimmunity, psychoneuroimmunology research/medical perspectives. Prerequisites: both CHM 231 (or 331) and MIC 205 (or 220) or only instructor approval.

## GRADUATE PROGRAMS AND COURSES

### **MIC 421 Experimental Immunology. (2)**

*fall and spring*

Introduces the basic techniques, methods, and assays used in immunology. 6 hours lab. Fee. Prerequisites: a combination of CHM 231 and 331 and MIC 302 or only instructor approval.

### **MIC 425 Advanced Immunology. (3)**

*selected semesters*

Survey of recent advances in immunology, including lymphocyte membranes, lymphokines/biochemistry, molecular genetics, theoretical immunology, immunoregulation, neuroimmunology, and immunologic diseases. Prerequisite: MIC 420 or instructor approval.

### **MIC 441 Bacterial Genetics. (3)**

*spring*

Survey of genetic exchange and regulatory processes in bacteria and their viruses. Bacteria and viruses as tools in genetic engineering. Prerequisites: both BIO 340 and MIC 205 (or 220) or only instructor approval.

### **MIC 442 Bacterial Genetics Laboratory. (1)**

*spring*

Techniques of mutagenesis, mapping, and strain and genetic library construction. 4 hours lab. Prerequisites: MIC 206, 302. Pre- or corequisite: MIC 441.

### **MIC 445 Techniques in Molecular Biology/Genetics. (2)**

*fall and spring*

Molecular genetic principles: plasmid construction, purification, and characterization; PCR; mutageneses; hybridization and sequence analysis; protein quantitation; immunologic detection and electrophoresis. Cross-listed as MBB 445. Credit is allowed for only MBB 445 or MIC 445. Prerequisites: both BIO 340 and MIC 302 or only instructor approval.

### **MIC 446 Techniques in Molecular Biology/Genetics Lab. (2)**

*fall and spring*

Molecular genetic techniques; plasmid construction, purification, and characterization; PCR; mutageneses; hybridization and sequence analysis; protein quantitation; immunologic detection and electrophoresis. Cross-listed as MBB 446. Credit is allowed for only MBB 446 or MIC 446. Pre- or corequisite: MBB 445 or MIC 445.

### **MIC 461 Geomicrobiology. (3)**

*spring*

Past and present interactions among microbial life, geological materials, and biogeochemical cycles involving carbon, sulfur, phosphate, nitrogen, and metals. Cross-listed as GLG 461. Credit is allowed for only GLG 461 or MIC 461. Prerequisites: introductory courses in chemistry and microbiology (or geological sciences); instructor approval.

### **MIC 470 Bacterial Diversity and Systematics. (4)**

*fall*

Biology, classification, and enrichment culture of the nonpathogenic bacteria. 2 hours lecture, 6 hours lab. Fee. Prerequisite: MIC 302.

### **MIC 485 General Virology. (3)**

*fall*

Fundamental nature of viruses, their replication, pathogenesis, and ecology. Prerequisites: both BIO 340 and CHM 331 or only instructor approval.

### **MIC 486 General Virology Laboratory. (2)**

*selected semesters*

Fundamentals of virus detection, isolation and assay; propagation of virus in mammalian cell culture; recombinant virus and vector construction. 6 hours lab. Prerequisite: MIC 302. Pre- or corequisite: MIC 485.

### **MIC 527 Neuroimmunology. (3)**

*selected semesters*

Studies mind's influence on immunity and the immune system's influence on the mind, neuroimmunologic diseases, and the neuroimmunological circuitry involved. Seminar. Prerequisite: MIC 420 or instructor approval.

### **MIC 581 Molecular Mechanism of Pathogenesis. (3)**

*selected semesters*

Pathogenic mechanisms and host responses in viral and/or bacterial diseases. Prerequisites: both MIC 381 and 420 or only instructor approval.

### **MIC 585 Molecular Virology. (3)**

*fall*

Selected topics concerning molecular aspects of eukaryotic virus replication and pathogenesis. Prerequisite: instructor approval.

### **MIC 591 Seminar. (1-12)**

*fall and spring*

Topics may include the following:

- Bacterial Ecology. (1-3)
- Current Research in Microbiology. (1-3)
- Enzymology. (1-3)
- Genetic Engineering. (1-3)
- Genetics. (1-3)
- Immunology. (1-3)
- Molecular Virology. (1-3)
- Neuroimmunology. (1-3)
- Pathogenic Bacteriology. (1-3)

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

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## Molecular and Cellular Biology

### Interdisciplinary Master's and Doctoral Programs

[www.asu.edu/mcb](http://www.asu.edu/mcb)

480/965-0743

LSE 411

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**Robert W. McGaughey, Director**

#### **Bioengineering**

Associate Professor: Massia

Assistant Professor: Panitch

#### **Biology**

Professors: Capco, Chandler, Hazel, McGaughey, Satterlie

Associate Professors: Goldstein, Orchinik

Assistant Professors: Kumar, Lorson, Newfeld, Wilson-Rawls

#### **Chemical and Materials Engineering**

Assistant Professor: Razatos

#### **Chemistry and Biochemistry**

Professors: Allen, Blankenship, Lohr, Rose, Woodbury

Research Professor: Bieber

Assistant Professor: Francisco

#### **Microbiology**

Professors: Jacobs, Misra, Schmidt

Associate Professors: Hoffman, Stout

Assistant Professor: Chang

#### **Plant Biology**

Professors: Backhaus, Frasch, Hooper, Trelease, Vermaas, Webber

Associate Professors: Roberson, Stutz

Assistant Professor: Rhoads

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The interdisciplinary M.S. and Ph.D. degrees in Molecular and Cellular Biology are administered by the Interdisciplinary Committee on Molecular and Cellular Biology. The

participating faculty are drawn primarily from four core departments (the Departments of Biology, Chemistry and Biochemistry, Microbiology, and Plant Biology), with additional faculty from the Departments of Anthropology, Bioengineering, Chemical and Materials Engineering, Exercise Science, Physics and Astronomy, and Psychology. One striking aspect of studies in this broad area of biological science is the interdisciplinary nature of the field. Similar approaches and techniques are used for studies of biological systems whether they are viral, bacterial, plant, or animal.

The graduate degrees offered by the faculty through this program prepare students for careers that span traditional disciplinary boundaries. The broad-based training provides the necessary skills for professional careers in academic institutions, governmental institutions, and industry, particularly those related to health and chemical sciences.

**Graduate Record Examination.** All applicants are required to take the Graduate Record Examination (GRE). Submission of scores on the verbal, quantitative, and analytical sections of the GRE is required for admission to the M.S. and Ph.D. degree programs. The subject test in the sciences is highly recommended.

**TOEFL and SPEAK Test.** Students whose native language is not English are required to take the Test of English as a Foreign Language (TOEFL). A TOEFL score of 630 (paper) or 267 (computer) is required for admission to the MCB program. Students whose native language is not English must pass the Speaking Proficiency English Assessment Kit (SPEAK) test with a score of at least 55 if they wish to be considered for teaching assistantship support.

### MASTER OF SCIENCE

See "Master's Degrees," page 93, for general requirements.

**Program of Study.** Thirty semester hours are required. A minimum of 10 designated semester hours of MCB courses and six hours of Research and Thesis are required. The remaining courses are selected by the student in consultation with the supervisory committee.

**Thesis Requirements.** A written thesis based on original research is required.

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

### DOCTOR OF PHILOSOPHY

See "Doctor of Philosophy," page 96, for general requirements.

**Program of Study.** Eighty-four semester hours are required. A minimum of 12 designated semester hours of MCB courses, six semester hours of elective course work, and 24 semester hours of Research and Dissertation are required. The remaining courses are selected by the student in consultation with the supervisory committee.

**Comprehensive Examinations.** Written and oral comprehensive examinations are required.

**Dissertation Requirements.** A written dissertation based on original research of high quality that demonstrates proficiency in the area of specialization is required.

**Final Examinations.** The final oral examination in defense of the dissertation is required. Evidence must be presented that the research contribution is publishable in the primary literature.

### RESEARCH ACTIVITY

The Interdisciplinary Program in Molecular and Cellular Biology offers research experiences and laboratory training at the forefront of biology. Recent completion of a new wing to the Life Science Center and the opening of the Goldwater Science and Technology Center have made state of the art resources available to students in the program. The faculty strive to provide an environment that builds a base for the pursuit of intellectual development throughout a student's lifetime.

#### MOLECULAR AND CELLULAR BIOLOGY (MCB)

##### MCB 500 Research Methods in Molecular and Cellular Biology. (2)

*fall and spring*

Rotation laboratory experiences in which students participate in research under the direction of an MCB faculty member. May be repeated for credit.

##### MCB 501 Seminar: Molecular and Cellular Biology Colloquium. (1)

*fall and spring*

Presentation of current research by noted researchers in the field. May be repeated for credit.

##### MCB 555 Advanced Molecular and Cellular Biology I. (3)

*fall*

Study of structural and functional organization of biomolecules and cells, based on current literature. May be repeated once for credit. 3 hours lecture, discussion. Pre- or corequisites: BCH 461; BIO 543 (or its equivalent).

##### MCB 556 Advanced Molecular and Cellular Biology II. (3)

*spring*

Continuation of MCB 555. May be repeated once for credit. 3 hours lecture, discussion. Pre- or corequisites: BCH 462; BIO 543 (or its equivalent).

##### MCB 576 Functional Genomics. (2)

*spring*

Functional relevance of genomic sequences; DNA arrays, proteomics, analysis of genomic information for metabolic physiology of organisms. Cross-listed as PLB 576. Credit is allowed for only MCB 576 or PLB 576. Prerequisite: MAT 351.

##### MCB 591 Seminar: Current Literature in Molecular and Cellular Biology. (1)

*fall and spring*

Presentation and discussion of current research in the areas of molecular and cellular biology. May be repeated for credit.

##### MCB 598 Special Topics. (1-4)

*selected semesters*

MCB 555 and 556 may be taken as one-semester-hour sections listed by the instructor.

##### MCB 700 Research Methods in Molecular and Cellular Biology. (2)

*fall and spring*

Rotation laboratory experiences in which students participate in research under the direction of an MCB faculty member. May be repeated for credit.

##### MCB 701 Seminar: Molecular and Cellular Biology Colloquium. (1)

*fall and spring*

Presentation of current research by noted researchers in the field. May be repeated for credit.



## GRADUATE PROGRAMS AND COURSES

### **MCB 791 Seminar: Current Literature in Molecular and Cellular Biology. (1)**

*fall and spring*

Presentation and discussion of current research in the areas of molecular and cellular biology. May be repeated for credit.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

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## Multimedia Writing and Technical Communication

### Certificate Program

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ASU East offers a postbaccalaureate certificate in Multimedia Writing and Technical Communication. For more information, call 480/727-1515, or access [www.east.asu.edu/ecollege/multimedia](http://www.east.asu.edu/ecollege/multimedia) on the Web.

### MULTIMEDIA WRITING AND TECHNICAL COMMUNICATION (TWC)

#### **TWC 401 Principles of Technical Communication. (3)**

*fall and spring*

Basic information design principles to produce effective written, oral, and electronic technical communication. Understanding of rhetorical and audience analysis. Pre- or corequisite: TWC 301.

#### **TWC 403 Writing for Professional Publication. (3)**

*selected semesters*

Analyzes the market and examines the publication process, including the roles of the author, editor, and reviewer. Pre- or corequisite: TWC 401.

#### **TWC 411 Principles of Visual Communication. (3)**

*fall and spring*

Basic principles of visual communication in print and electronic media. Understanding graphic and document design, including typography and color. Pre- or corequisite: TWC 401.

#### **TWC 421 Principles of Writing with Technology. (3)**

*fall and spring*

Understanding historical and social impact of technology on writing, with emphasis on multimedia design, computer-mediated communication, and hypertext. Pre- or corequisite: TWC 401.

#### **TWC 431 Principles of Technical Editing. (3)**

*fall and spring*

Basic principles of technical editing (for print and electronic media) including copyediting, reviews, standards, style, and project management. Pre- or corequisite: TWC 401.

#### **TWC 443 Proposal Writing. (3)**

*once a year*

Develops persuasive strategies and themes for researching and writing professional proposals. Pre- or corequisite: TWC 401.

#### **TWC 444 Manual and Instructional Writing. (3)**

*once a year*

Design and development of a user manual, writing instructions, improving graphics and page design, and usability testing. Pre- or corequisite: TWC 401.

#### **TWC 445 Computer Documentation. (3)**

*once a year*

Introduces writing documentation for the computer industry. Pre- or corequisite: TWC 401.

#### **TWC 446 Technical and Scientific Reports. (3)**

*once a year*

Introduces strategies, formats, and techniques of presenting information to technical and scientific audiences. Pre- or corequisite: TWC 401.

#### **TWC 447 Business Reports. (3)**

*once a year*

Introduces strategies, formats, and techniques of presenting information to business and other workplace audiences. Pre- or corequisite: TWC 401.

#### **TWC 484 Internship. (3)**

*fall and spring*

Applies classroom work in a supervised workplace environment. Pre- or corequisite: TWC 411 or 421 or 431.

#### **TWC 490 Capstone. (3)**

*fall and spring*

Development of a professional portfolio, creation of a "culminating document," and synthesis of undergraduate experience. Prerequisite: instructor approval.

#### **TWC 501 Principles of Technical Communication. (3)**

*fall and spring*

Basic information design principles to produce effective written, oral, and electronic technical communication. Understanding of rhetorical and audience analysis. Pre- or corequisite: graduate standing.

#### **TWC 503 Writing for Professional Publication. (3)**

*selected semesters*

Analyzes the market and examines the publication process, including the roles of the author, editor, and reviewer. Pre- or corequisite: TWC 501.

#### **TWC 511 Principles of Visual Communication. (3)**

*fall and spring*

Basic principles of visual communication in print and electronic media. Understanding graphic and document design, including typography and color. Pre- or corequisite: TWC 501.

#### **TWC 521 Principles of Writing with Technology. (3)**

*fall and spring*

Understanding historical and social impact of technology on writing, with emphasis on multimedia design, computer-mediated communication, and hypertext. Pre- or corequisite: TWC 501.

#### **TWC 531 Principles of Technical Editing. (3)**

*fall and spring*

Basic principles of technical editing for print and electronic media, including copyediting, reviews, standards, style, and project management. Pre- or corequisite: TWC 501.

#### **TWC 543 Proposal Writing. (3)**

*once a year*

Develops persuasive strategies and themes for researching and writing professional proposals. Pre- or corequisite: TWC 501.

#### **TWC 544 Manual and Instructional Writing. (3)**

*once a year*

Design and development of a user manual, writing instructions, improving graphics and page design, and usability testing. Pre- or corequisite: TWC 501.

#### **TWC 545 Computer Documentation. (3)**

*once a year*

Introduces writing documentation for the computer industry. Pre- or corequisite: TWC 501.

#### **TWC 546 Technical and Scientific Reports. (3)**

*once a year*

Introduces strategies, formats, and techniques of presenting information to technical and scientific audiences. Pre- or corequisite: TWC 501.

#### **TWC 547 Business Reports. (3)**

*once a year*

Introduces strategies, formats, and techniques of presenting information to business and other workplace audiences. Pre- or corequisite: TWC 501.

#### **TWC 584 Internship. (3)**

*fall and spring*

Applies classroom work in a supervised workplace environment. Pre- or corequisites: TWC 511, 521, 531.

#### **TWC 598 Special Topics. (1–4)**

*selected semesters*

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

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## Museum Studies

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See “Certificate in Museum Studies,” page 105.

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## Music

### Master’s, Doctoral, and Certificate Programs

[herbergercollege.asu.edu/music](http://herbergercollege.asu.edu/music)

480/965-3371

MUSIC E185

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Wayne A. Bailey, Director

Amy Holbrook, Graduate Program Coordinator

**Regents’ Professors:** Hickman, Pagano

**Professors:** Bailey, Britton, Cosand, Crowe, DeMars, Doan, Dreyfoos, Hackbarth, Hamilton, Hill, Hoffer, Humphreys, Kliewer-Britton, Koonce, Lockwood, Marohnic, Metz, Oldani, Pilafian, Reber, Rogers, Russell, Sellheim, Shinn, Spring, Stauffer, Sunkett, Swaim, Thompson, Umberson, Williamson, Wytko

**Associate Professors:** Bush, Carpenter, Haefer, Holbrook, Kopta, Lyman, Marshall, May, Peterson, Rockmaker, Rodland, Smith, Solis, Wilson

**Assistant Professors:** Bryan, Ericson, Landschoot, Lingas, McLin, Meir, Rio, Schmidt, Schuring, Sullivan, Swartz

**Senior Lecturers:** Norton, Shellans

**Lecturer:** Tongret

**Academic Professional:** Campbell

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The School of Music in the Katherine K. Herberger College of Fine Arts at ASU is an accredited institutional member of the National Association of Schools of Music. The requirements for entrance and graduation set forth in this catalog are in accordance with the published regulations of the association.

The School of Music is committed to the growth and development of both faculty and students in order that music may be created, performed, studied, and taught with excellence.

The faculty in the School of Music offer graduate programs leading to the M.A. degree in Music with concentrations in ethnomusicology, music history and literature, and music theory.

The faculty also offer a graduate program leading to the professional Master of Music degree in Composition, Music Education, and Performance and the professional Doctor of

Musical Arts degree in Music with concentrations in choral conducting, music composition, music education, and solo performance.

**Graduate Diagnostic Examinations.** All students admitted to graduate degree programs must satisfactorily complete these examinations before any comprehensive examinations may be scheduled. In music theory, the areas are as follows:

1. aural skills;
2. form;
3. analytical skills: 19th-century music; and
4. analytical skills: contemporary music.

In music history, the areas are (1) medieval, renaissance, and baroque and (2) classical, romantic, and contemporary.

**Undergraduate Deficiencies.** Deficiencies are determined by the school. Removal of all deficiencies is the responsibility of the student and is considered additional to the minimum hours for graduation.

**Graduate Assistantships.** The deadline is February 15 for teaching assistantship applications.

### MASTER OF ARTS

See “Master’s Degrees,” page 93, for general requirements.

**Prerequisites.** Applicants are expected to have a B.A. degree in Music or its equivalent from an accredited institution.

**Admission.** Application must be accompanied by evidence of scholarly achievement or potential (e.g., a term paper), letters of recommendation from two persons qualified in the field, and a one- to- two-page personal statement of the applicant’s professional goals.

### Program of Study

**Ethnomusicology.** A minimum of 30 semester hours of graduate credit is required, of which at least 20 semester hours must be in the field of ethnomusicology or related fields, including six semester hours of thesis, and at least six semester hours in music theory.

**Music History and Literature.** A minimum of 30 semester hours of graduate credit is required, of which at least two-thirds must be in the field of music history and literature and at least six semester hours in music theory.

**Music Theory.** A minimum of 32 semester hours of graduate credit is required, of which at least 18 must be in the field of music theory and at least 10 must be selected from the fields of music theory, music composition, and music history.

### Course Requirements

**Ethnomusicology.** MUP 587 (two semesters), MHL 568, 591, 592, 599 (Thesis), and six semester hours of music theory.

## GRADUATE PROGRAMS AND COURSES

**Music History and Literature.** MUP 582 (two semesters), MHL 532, 591 (two semesters), 599 (Thesis), and six hours of music theory.

**Music Theory.** MTC 520, 525, 527, 528, 599 (Thesis); six semester hours of music history.

**Foreign Language Requirements.** A passing grade on the foreign language reading examination in French or German is required.

**Final Examinations.** A final examination (written, oral, or both) is required. An oral examination in defense of the thesis is also required.

### MASTER OF MUSIC

The faculty in the School of Music offer a graduate program leading to the professional degree Master of Music (M.M.). Three majors are available: Composition, Music Education, and Performance. For the Music Education major, concentrations are available in

1. choral music,
2. general music,
3. instrumental music, and
4. jazz studies.

Performance majors may focus their education in the following areas of concentration:

1. music theatre/opera musical direction,
2. music theatre/opera performance,
3. performance,
4. performance pedagogy, and
5. piano accompanying.

**Prerequisites.** A Bachelor of Music degree or its equivalent from an accredited institution is required for admission to the M.M. program.

**Admission.** Admission to all concentrations under the major in Performance is dependent on a successful audition, either in person or by taped performance. For admission to the major in Composition, the applicant must submit three original works showing technical facility in composition, letters of recommendation from two qualified persons in the field, and a one- to two-page personal statement of the applicant's professional goals. For admission to the M.M. in Music Education degrees, the applicant must have completed all requirements for music teacher certification. Post-baccalaureate certification is available and may be completed concurrently with master's degree work.

Letters of recommendation from three qualified persons in the field are also required. For the jazz studies concentration, a video or audio tape of a recent jazz performance (solo or ensemble) by the applicant must be submitted, and a video or audio tape of a jazz ensemble directed by the applicant should also be submitted if available.

Students majoring in Performance with a concentration in solo performance (voice) and performance pedagogy (voice) are required to take a diction examination in French, German, and Italian during registration week of their first

semester. Students who do not pass this examination are required to take the appropriate semester(s) of MUP 250.

For admission to the concentration in performance pedagogy (piano), a minimum of one semester of prior piano pedagogy study including significant intern teaching experience is required. In addition, the student must demonstrate evidence of teaching ability, either in person or by videotape.

**Program of Study.** The student must complete a minimum of 32 semester hours of graduate courses, of which at least one-third must be in the area of concentration.

**Foreign Language Requirements.** Solo performance (voice only) and performance pedagogy (voice only) require a total of 16 semester hours of college-level credit in more than one language chosen from French, German, or Italian. The concentration in piano accompanying requires two semesters of college-level study in French, German, or Italian and two semesters of diction (or the equivalent) in the remaining languages in that group. These requirements may be fulfilled in whole or in part through language instruction in secondary and/or undergraduate school or by other means (for more information, see the *General Catalog*). These language requirements are not part of the 32-hour program of study. However, hours toward the requirements may be taken concurrently with the program of study if a deficiency exists.

**Final Examination.** A final examination (written, oral, or both) is required. An oral examination in defense of the thesis is required for the major in composition.

### COURSE REQUIREMENTS

#### Composition

*Composition.* MTC 523 (six semester hours), 525, 599; six hours of music history, three hours of music theory.

#### Music Education

*Choral Music.* MUE 548, 549, 550 (or 579), 568, 570; two semester hours of ensemble; six semester hours of music history (including MHL 575); five hours of music theory. One MHL or MTC course must be in contemporary music.

*General Music.* MUE 548, 549, 550 (or 579), 551, 552; six semester hours of music history; five hours of music theory. One MHL or MTC course must be in contemporary music, and one MHL course or one ensemble must be in ethnomusicology.

*Instrumental Music.* MUE 548, 549, 550 (or 579), 564, 566; six semester hours of music history; five hours of music theory. One MHL or MTC course must be in contemporary music.

*Jazz Studies.* MUE 548, 549, 550 (or 579), 560, 562 (two semesters); MUP 509, 510, 517, 518, three semester hours of jazz ensemble; six semester hours of music history; five hours of music theory. One MHL or MTC course must be in contemporary music.

## Performance

*Solo Performance (Voice).* MUP 527 (eight semester hours), 541, 551, 596, 597; performing ensembles (two hours); six hours of music history; five hours of music theory.

*Solo Performance (Keyboard).* MUP 527 (eight semester hours), 551 (or 581), 596, 597; performing ensembles (two hours); six hours of music history and literature; five hours of music theory.

*Solo Performance (Instrumental).* MUP 527 (eight semester hours), 551, 581, 596, 597; performing ensembles (two hours); six hours of music history; five hours of music theory.

*Piano Accompanying.* MUP 527 Studio Instruction (eight semester hours), 511 (or 521 Studio Instruction [four hours]), 588 (four hours), 596, 597; six hours of music history; five hours in music theory.

*Performance Pedagogy.* MUP 527 (eight semester hours), 541 (voice only), 551 and/or 581, 596, 597; performing ensembles (two hours), (piano only: MUP 440 [or proficiency], 507, 508, 581 [four hours]); six hours in music history; five hours of music theory.

*(Music Theatre/Opera) Musical Direction.* MUP 511 Studio Instruction: Piano (four semester hours), 551, 571 (two semester hours), 573, 574 (two semester hours), 591 (six semester hours), 596, 597; performance on stage in one production; musical direction of two productions; six hours of music history; five hours of music theory.

*(Music Theatre/Opera) Performance.* MUP 511 Studio Instruction (eight semester hours), 551, 570 (two semester hours), 571 (three semester hours), 596, 597; a three-hour graduate THP course designed for actors (as approved by supervisory committee); leading roles in two musical theatre productions; six hours of music history; five hours of music theory.

## DOCTOR OF MUSICAL ARTS

The Doctor of Musical Arts (D.M.A.) is a professional degree program designed for students desiring high levels of performance, academic proficiency, and preparation for teaching positions at the university level. The major is Music with four concentrations: choral conducting, music composition, music education, and solo performance (instrumental, keyboard, piano accompanying, piano pedagogy, voice).

**Admission.** Students seeking admission normally hold the Master of Music degree. Applicants with other degrees are considered if they have received graduate training similar to that normally expected in a Master of Music degree program. The application for admission must be accompanied by an applicant's statement relating to goals, preparation, and educational background. The applicant must submit scores for the GRE (quantitative, verbal, and analytical) or the MAT. Three letters of recommendation are required. Applicants must perform a satisfactory audition or submit a tape recording of performances or compositions as appropriate to the concentration. The deadline is February 15 for teaching assistantship applications.

**Supervisory Committee.** When the program of study is filed, the supervisory committee is appointed by the dean of the Graduate College upon recommendation of the director and the graduate committee of the School of Music. The committee consists of five members; at least three should be from the major field.

**Program of Study.** A total of 90 semester hours beyond the bachelor's degree is required. Only 36 hours from a master's degree or other postgraduate work will be counted toward the 90 hour requirement. For more information, call the School of Music, 480/965-3371.

**Continuous Enrollment.** Once admitted to a D.M.A. degree program, the student is expected to be enrolled continuously, excluding summer sessions, until all requirements for the degree have been fulfilled. This requirement applies to students admitted fall 1994 and thereafter. Continuous enrollment promotes steady progress toward the completion of the degree and an ongoing relationship between the student and faculty offering the program. If a program of study must be interrupted for one or more semesters, the student may apply for leave status, not to exceed one calendar year. A student on leave is not required to pay fees, but is not permitted to place any demands on university faculty or use any university facilities. A student who interrupts a program without obtaining leave status may be removed automatically from the Graduate College, under the assumption that the student has decided to discontinue the program. A student removed from the Graduate College for this reason may reapply for admission; the application is considered along with all other new applications to the degree program.

An application for leave status, endorsed by the members of the student's supervisory committee and the head of the academic unit, must be approved by the dean of the Graduate College. This request must be filed and approved no later than the last day of registration in the semester of anticipated absence.

**Residency.** In general, the D.M.A. degree student should expect to spend at least the equivalent of three academic years beyond the bachelor's degree in the program. At least two semesters following the first year (30–32 semester hours) of graduate study must be spent in continuous full-time residence at ASU. After the first year (30–32 semester hours), at least 54 hours must be completed in residence at ASU.

**Foreign Language Requirements.** Competency in at least one foreign language is required for solo performance and music composition concentrations. Some areas of study within solo performance require two foreign languages.

**Comprehensive Examinations.** Near the completion of course work, the student must request permission to take the comprehensive examinations through the supervisory committee and the school director. These written and oral examinations are designed to assess the student's competency in the major and supportive fields. Failure in the comprehensive examinations is considered final unless the supervisory committee recommends, and the dean of the Graduate College approves, a reexamination. A reexamination may be administered no sooner than three months and no later than

## GRADUATE PROGRAMS AND COURSES

one year from the date of the original examination. Only one reexamination is permitted.

**Candidacy.** Doctoral students should apply for admission to candidacy immediately after they have met all requirements for the degree, *except the dissertation*. These requirements include passing the comprehensive examinations and foreign language examination, if applicable, and meeting other requirements specified by the academic unit.

**Dissertation, Research Papers, and Recitals.** The music composition and music education concentrations require a dissertation of an original and creative nature. The choral conducting concentration requires a conducting recital plus either a dissertation or a series of projects and a research paper. The solo performance concentration requires at least three recitals following admission to the program and a research paper. All candidates must enroll for a total of 24 semester hours of credit in research (MUP 792), recital (MUP 796), and dissertation (MUP 799) as appropriate to the concentration.

**Final Examinations.** The final oral examination in defense of the dissertation or research paper is scheduled by the Graduate College. The exam is conducted by the supervisory committee and others appointed by the dean of the Graduate College. All final oral examinations must be conducted at least one week before the degree conferral date and held on the ASU Main campus.

**Graduation.** The student is eligible for graduation when the final oral examination has been passed, Graduate College scholarship requirements have been met, and the dissertation/research paper has been approved by the supervisory committee, the director of the school, and the dean of the Graduate College.

Applications for graduation should be made no later than the date specified in the Graduate College calendar.

**Maximum Time Limit.** D.M.A. candidates must complete all requirements within five years after the comprehensive exams have been passed.

### POST-BACHELOR'S ARTIST DIPLOMA

The Post-Bachelor's Artist Diploma graduate certificate program is intended for a very limited number of the most gifted performers who demonstrate strong potential for successful careers in musical performance.

**Admission.** Students seeking admission must hold at least a bachelor's degree in music or an equivalent conservatory credential at the time of entrance. All applicants whose native language is not English must submit a score of at least 550 on the Test of English as a Foreign Language (TOEFL). For preliminary screening, every applicant must submit a letter of application, official transcripts, four letters of recommendation, and an audio recording containing works representing a variety of musical styles and composers. Those applicants recommended for a full audition must perform an audition recital and be interviewed on the ASU campus.

**Program of Study.** The Post-Bachelor's Artist Diploma program is a two-year course of study requiring at least two consecutive semesters of residence. A total of 32 semester hours, including four public recitals, is required. Three of the recitals must be presented on the ASU campus, and one at a venue outside of the metropolitan Phoenix area.

**Course Requirements.** MUP 527 (sixteen semester hours), 551 (four semester hours), and 581; performing ensembles (two semester hours) and four recitals (eight semester hours).

**Related Requirements.** The School of Music graduate diagnostic examinations in music theory and music history must be taken during the first semester of study, and all must be passed before the awarding of the Post-Bachelor's Artist Diploma. Students in voice must pass the graduate-level foreign language diction examination before completing the program. Concurrent enrollment in other degree programs during the course of study is not permitted. Transfer credits from other institutions and/or other degree programs within the ASU School of Music do not count toward the 32 required semester hours.

### MUSIC HISTORY/LITERATURE (MHL)

#### MHL 532 Music Bibliography. (3)

*fall*

Major historical and analytical writings; systematic and historical collections of music. Prerequisite: reading knowledge of a foreign language recommended.

#### MHL 535 Medieval Music. (3)

*spring in odd years*

Music of Europe in the Middle Ages, Gregorian chant, religious and secular monophony and polyphony to 1400.

#### MHL 536 Music of the Renaissance. (3)

*spring in even years*

Music in Europe, with emphasis on stylistic concepts and changes, ca. 1400–1580.

#### MHL 544 World Music I. (3)

*fall in odd years*

Music of traditional and folk cultures of Africa, Europe, and the Americas.

#### MHL 545 World Music II. (3)

*fall in even years*

Traditional, folk, and art music of the Pacific, Near East, and Asia.

#### MHL 547 Topics in American Music. (3)

*selected semesters*

Selected topics in the history of music. Composers working in the Americas with emphasis upon music since 1900.

#### MHL 557 Topics in Symphonic Literature. (3)

*spring in even years*

Examines the evolution of the symphony and symphonic poem from the early classic era through the 19th century, with emphasis on the analysis of selected works.

#### MHL 564 History of Music Instruments. (3)

*fall in even years*

Survey of the history and development of music instruments in traditional, folk, and art cultures.

#### MHL 566 Area Studies in Ethnomusicology. (3)

*spring*

Study of the music of a particular culture, country, or area (e.g., music of Mexico, Latin America, China, Africa). May be repeated for credit.

#### MHL 568 Introduction to Ethnomusicology. (3)

*fall in odd years*

Introduces the theory and methodology of the discipline, including bibliography, fieldwork, transcription, analysis, and organology.

**MHL 575 History of Choral Music. (3)***fall*

Major choral works.

**MHL 591 Seminar. (1–12)***fall and spring***MHL 592 Research. (1–12)***fall and spring***MHL 599 Thesis. (1–12)***fall and spring***MHL 644 Notation of Polyphonic Music. (3)***spring in even years*

Music notation from the 15th through 17th centuries, including problems of transcription into modern notation.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.**MUSIC THEORY AND COMPOSITION (MTC)****MTC 516 Baroque Music. (3)***spring in even years*

Detailed analysis of selected examples of music from the Baroque period.

**MTC 517 Classic Music. (3)***spring in odd years*

Detailed analysis of selected examples of music from the Classic period.

**MTC 518 Romantic Music. (3)***fall in even years*

Detailed analysis of selected examples of music from the Romantic period.

**MTC 519 Late 19th-/Early 20th-Century Music. (3)***fall in odd years*

Detailed analysis of selected examples of music from the late 19th and early 20th centuries.

**MTC 520 Analytical Techniques. (3)***spring and summer*

Analytical techniques systematically applied to music. Concentration on structural and compositional procedures.

**MTC 523 Advanced Composition. (2–3)***fall and spring*

Advanced music composition, including complex techniques and larger structure. May be repeated for credit. Prerequisite: instructor approval.

**MTC 525 Pedagogy of Theory. (3)***fall in even years*

Practices and principles of teaching music theory. Emphasizes most desirable and practical offerings possible. Comparative studies of existing practices.

**MTC 527 History of Music Theory. (3)***selected semesters*

Theory from Pythagoras to the 16th century. Need not be taken in sequence with MTC 528.

**MTC 528 History of Music Theory. (3)***selected semesters*

Theory from the 17th century to the present. Need not be taken in sequence with MTC 527.

**MTC 555 Computer Music Notation. (2)***selected semesters*

Instruction in preparing score and parts of music compositions using various music-notation software packages. Credit cannot be applied toward the graduate theory requirement. Lecture, lab. Prerequisite: instructor approval.

**MTC 591 Seminar. (1–12)***fall and spring***MTC 592 Research. (1–12)***fall and spring***MTC 599 Thesis. (1–12)***fall and spring***MTC 647 Directions in New Music. (3)***selected semesters*

Studies in contemporary idioms and aesthetics drawn from recent works of visiting composers; involves analytical discourse, critical writ-

ing, and applied concepts in composition. Lecture, discussion, exercise. Prerequisite: instructor approval.

**MTC 723 Advanced Composition. (3)***fall and spring*

Special problems in writing in complex forms and textures. May be repeated for credit. Studio.

**MTC 755 Music Composition Technology. (3)***selected semesters*

Advanced study in digital sampling, synthesis, sequencing, computer-generated sound, and computer/performer interfaces. May be repeated for credit. Lecture, lab. Prerequisites: MTC 436 and 437 (or their equivalents).

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.**MUSIC EDUCATION (MUE)****MUE 548 Introduction to Research in Music Education. (3)***fall and summer*

Introduces historical, quantitative, and qualitative research methods and sources as they apply to research in music education.

**MUE 549 Foundations of Music Education. (3)***once a year*

Historical/sociological survey of formal and informal music teaching and learning practices from the ancient Greeks to the present, including the evolution of philosophies and learning theories.

**MUE 550 Studies in Music Curricula. (3)***once a year*

Scope and sequence of musical experiences. Development of criteria for the evaluation of music curricula.

**MUE 551 Advanced Studies in Elementary School Music. (3)***once a year*

For experienced teachers; organization and content of K–6 general music classes. Emphasizes teaching music reading and ear training to young children.

**MUE 552 Advanced Studies in Secondary General Music. (3)***once a year*

Organization and content of school music classes that are not performance oriented.

**MUE 553 Contemporary Elementary Music. (3)***selected semesters*

Identification and development of materials and techniques for teaching special units of music study to elementary (K–8) children.

**MUE 560 Jazz Pedagogy. (3)***spring in odd years*

Study of pedagogy, repertoire, and technique of instruction in jazz styles, ensemble techniques, and performance practice for school ensembles. Lecture, lab, discussion, observation. Prerequisite: M.M., Music Education major.

**MUE 562 Jazz Ensemble Rehearsal Techniques. (1)***fall and spring*

Conducting and rehearsal techniques for school jazz ensembles. Lab. Prerequisite: M.M., Music Education major.

**MUE 564 Instrumental Music, Advanced Rehearsal Techniques. (3)***once a year*

In-depth analysis of instrumental techniques in preparation for a thorough discussion of band tuning problems and solutions. Discussion of productive conducting and rehearsal techniques for school music teachers.

**MUE 566 Instrumental Literature for Schools. (3)***once a year*

Comprehensive study and analysis of all types of instrumental music.

**MUE 568 Choral Music, Advanced Rehearsal Techniques. (3)***once a year*

Musical and vocal techniques necessary for presentation of choral literature. Analysis and experimentation with psychological, acoustical, and other problems of rehearsal and performance.

**MUE 570 Choral Literature for Schools. (3)***once a year*

Comprehensive study and analysis of choral music for the high school with special emphasis on octavo literature.

## GRADUATE PROGRAMS AND COURSES

### **MUE 579 Psychology of Music. (3)**

*once a year*

Nature of musicality and its evaluation. Review of recent research.

### **MUE 585 Vocal Acoustics and Production. (3)**

*once a year*

In-depth approach to the psychological/physiological workings of the vocal mechanism.

### **MUE 733 Contemporary Issues and Research in Music Education. (3)**

*once a year*

Emphasizes recent research relating to music instruction at all levels; current and historical issues in choral, general, and instrumental music.

### **MUE 744 Higher Education Instruction. (3)**

*once a year*

Philosophical and psychological principles of college/university teaching. Patterns of music teacher education and a projection of course outlines.

### **MUE 755 Historical Research in Music Education. (3)**

*summer*

Knowledge and insights related to conducting historical research in music education. Includes development of a mini-proposal for a dissertation on the history of music education.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

## MUSIC PERFORMANCE (MUP)

### **MUP 507 Group Piano Practicum. (2)**

*fall*

Curricula, materials, and teaching techniques for group teaching at the university and community college levels. Observation/supervised teaching in group piano.

### **MUP 508 Studio Observation. (1)**

*fall and spring*

Weekly observation of studio teaching by various piano faculty. Paper as final requirement. Prerequisite: M.M. piano student in Performance major (performance pedagogy or solo performance concentration).

### **MUP 509 Jazz Keyboard Harmony. (1)**

*fall*

Emphasizes jazz chords and chord progressions, harmonization, voicing, and analysis of transcriptions. Lab. Prerequisite: M.M., Music Education student.

### **MUP 510 Jazz Keyboard Harmony. (1)**

*spring*

Continuation of MUP 509. Lab. Prerequisite: MUP 509.

### **MUP 511 Studio Instruction. (2)**

*fall and spring*

Bassoon, cello, clarinet, contrabass, cornet, euphonium, flute, guitar, harp, harpsichord, horn, oboe, organ, percussion, piano, saxophone, trombone, trumpet, tuba, viola, violin, voice. Minimum contact of 1 hour plus studio class weekly. May be repeated for credit. May not be taken for audit. Fee. Prerequisites: graduate music major; placement examination; audition.

### **MUP 517 Advanced Improvisation. (1)**

*fall*

Improvisation techniques within the context of advanced jazz literature. Must be taken in sequence with MUP 518. Lab. Prerequisites: placement examination; audition.

### **MUP 518 Advanced Improvisation. (1)**

*spring*

Continuation of MUP 517. Lab. Prerequisite: MUP 517.

### **MUP 521 Studio Instruction. (1)**

*fall, spring, summer*

Secondary or minor instrument instruction. Bassoon, cello, clarinet, contrabass, cornet, euphonium, flute, guitar, harp, harpsichord, horn, oboe, organ, percussion, piano, saxophone, trombone, trumpet, tuba, viola, violin, voice. Minimum contact of 1/2 hour per week. May be repeated for credit. May not be taken for audit. Fee. Prerequisites: graduate music major; instructor approval.

### **MUP 527 Studio Instruction. (2 or 4)**

*fall and spring*

Bassoon, cello, clarinet, contrabass, cornet, euphonium, flute, guitar, harp, harpsichord, horn, oboe, organ, percussion, piano, saxophone, trombone, trumpet, tuba, viola, violin, voice. Minimum contact of 1/2 hour per week. May be repeated for credit. May not be taken for audit. Fee. Prerequisites: M.M., Performance major; placement examination; audition.

### **MUP 540 Advanced Conducting. (3)**

*fall*

Score preparation and conducting techniques for instrumental music. Concentration on study of historical styles. Required of D.M.A. students in Instrumental Music.

### **MUP 541 The Art Song. (3)**

*selected semesters*

Seminar on solo song from its beginning to the present day.

### **MUP 544 Chamber Orchestra. (1)**

*fall and spring*

Important masterpieces from all periods of music are performed throughout the year. May be repeated for credit. Prerequisite: instructor approval.

### **MUP 545 Symphony Orchestra. (1)**

*fall and spring*

Masterpieces of symphony orchestra literature. 3 times per week. May be repeated for credit. Prerequisite: audition with director.

### **MUP 546 Sinfonietta. (1)**

*fall and spring*

Symphonic orchestra that presents approximately six concerts annually, performing masterpieces of the classical repertoire. 3 times per week. May be repeated for credit. Prerequisite: audition with director.

### **MUP 550 Choral Union. (1)**

*fall and spring*

Open to all students in the university and to interested singers in the community by audition. Preparation and performance of the larger choral works. 2 hours per week. May be repeated for credit. Prerequisite: audition with director.

### **MUP 551 Repertoire. (2)**

*fall and spring*

Literature available for performance in all performing media. May be repeated for credit.

### **MUP 552 Concert Choir. (1)**

*fall and spring*

Important masterpieces from all periods of music are performed. May be repeated for credit. Prerequisite: instructor approval.

### **MUP 553 University Choir. (1)**

*fall and spring*

4 hours per week. May be repeated for credit. Prerequisite: instructor approval.

### **MUP 555 Men's Chorus. (1)**

*fall and spring*

Rehearsal and performance of music for male voices. 3 hours per week. May be repeated for credit. Prerequisites: audition with director; instructor approval.

### **MUP 557 Women's Chorus. (1)**

*fall and spring*

2 hours per week. May be repeated for credit. Prerequisite: instructor approval.

### **MUP 561 Marching and Concert Bands. (1)**

*fall and spring*

Staging of formations and drills for football games and other events (fall); masterpieces of symphonic band literature (spring). Meets daily. May be repeated for credit. Prerequisite: audition with director.

### **MUP 562 Wind Ensemble. (1)**

*fall and spring*

Rehearsal and performance of literature for wind ensemble. 2 hours per week in fall, 4 hours in spring. May be repeated for credit. Performing ensemble. Prerequisite: instructor approval.

### **MUP 563 Chamber Winds. (1)**

*fall and spring*

Rehearsal and performance of advanced literature for chamber winds. 2 hours per week. May be repeated for credit. Performing ensemble. Prerequisite: instructor approval.

**MUP 570 Music Theatre: Techniques. (1)***fall and spring*

Exercises and improvisations for the singing actor emphasizing body awareness, isolations, and freedom of the vocal and breath mechanisms. Section 1 (Interpretation); Section 2 (Expression); Section 3 (Movement for Singers). Each Section: 3 hours per week. May be repeated for credit.

**MUP 571 Music Theatre: Workshops. (1)***fall and spring*

Development of specific skills for the musical-dramatic interpretation. Section 1 (Role Preparation); Section 2 (Styles); Section 3 (Opera Scenes); Section 4 (Musical Comedy); Section 5 (Revue Ensembles). Each section: 1 hour lecture, demonstration, 1 lab per week. May be repeated for credit.

**MUP 572 Music Theatre: Orchestras. (1)***fall and spring*

Participation in Lyric Opera Theatre productions. Section 1 (Orchestra); Section 2 (Chamber Orchestra); Section 3 (Chamber Ensemble). May be repeated for credit. Prerequisites: audition with director; instructor approval.

**MUP 573 Music Theatre: Performance. (1)***fall and spring*

Participation in Lyric Opera Theatre productions. Section 1 (Principal Roles); Section 2 (Chorus). May be repeated for credit. Prerequisites: audition with director; instructor approval.

**MUP 574 Music Theatre: Production. (1)***fall and spring*

Participation in Lyric Opera Theatre productions. Section 1 (Vocal Performance); Section 2 (Technical Music Theatre); Section 3 (Problems in Production) to be taken concurrently with MUP 573, Section 2. May be repeated for credit.

**MUP 576 New Music Ensemble. (1)***fall and spring*

Rehearsal and performance of music written in the last 20 years. May be repeated for credit. Prerequisite: instructor approval.

**MUP 579 Chamber Music Ensembles. (1)***fall and spring*

String, brass, woodwind, percussion, keyboard, vocal, and mixed ensembles. 2 hours per week. May be repeated for credit. Prerequisite: instructor approval.

**MUP 581 Performance Pedagogy and Materials. (2)***fall and spring*

Principles and methods of performance techniques for each performance field. May be repeated for credit.

**MUP 582 Collegium Musicum. (1)***selected semesters*

Singers and instrumentalists specializing in the performance of early and unusual music. 2 hours per week. May be repeated for credit. Prerequisite: instructor approval.

**MUP 585 Percussion Ensemble. (1)***fall and spring*

Rehearsal and performance of standard and original repertoire for the percussion ensemble and related instruments. 2 hours per week. May be repeated for credit. Prerequisite: instructor approval.

**MUP 586 Jazz Band. (1)***fall and spring*

Rehearsal and performance of new, traditional, and Latin literature for jazz bands. 4 hours per week. May be repeated for credit. Prerequisite: instructor approval.

**MUP 587 Ethnomusicology Ensembles. (1)***fall and spring*

Performance learning experience for the music of various cultures of the world. May be repeated for credit. Prerequisite: knowledge of instrument or instructor approval.

**MUP 588 Piano Accompanying. (1)***fall and spring*

Piano accompaniments found in vocal and instrumental literature; discussion of styles and performance practices; experience in public performance. 2 hours per week. May be repeated for credit. Prerequisite: Performance major with a concentration in piano accompanying or instructor approval.

**MUP 591 Seminar. (1–12)***selected semesters***MUP 595 Continuing Registration. (1)***fall and spring***MUP 596 Solo Performance. (1)***fall*

May be full recital, major operatic role, solo performance with orchestra, ensemble, or lecture recital. Prerequisite: M.M. candidate in applied music.

**MUP 597 Solo Performance. (1)***fall*

See MUP 596.

**MUP 671 Choral Repertoire. (3)***selected semesters*

Examines large choral/orchestral works to determine their musical and textual characteristics from a conductor's point of view.

**MUP 727 Studio Instruction. (2 or 4)***fall and spring*

Minimum contact of 1 hour per week. May be repeated for credit. Fee. Prerequisite: D.M.A. candidate.

**MUP 751 Seminar in Piano Literature. (2)***fall in odd years*

In-depth study of selected topics related to the standard piano literature. Requires research paper, bibliography, class presentation. Seminar.

**MUP 792 Research. (1–12)***fall, spring, summer***MUP 796 Solo Performance. (1–15)***fall and spring*

May be repeated for credit. Prerequisite: D.M.A. candidate.

**MUP 799 Dissertation. (1–15)***fall and spring*

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

## Music Education

See "Music," page 273.

## Natural Science

### Master's Program

The Master of Natural Science (M.N.S.) degree offers the opportunity for interdisciplinary graduate training in the natural sciences (biological sciences, mathematics, and physical sciences) and cognate areas. The degree program is especially suited for individuals who desire professional training rather than research training. Because of designed flexibility, the degree also offers the opportunity for individualized professional graduate programs depending upon the backgrounds and goals of the students. The major is Natural Science; students are expected to emphasize course work in two or more areas of concentration. The program must be interdisciplinary.



## GRADUATE PROGRAMS AND COURSES

More information can be found under the various majors in the natural sciences and by contacting faculty offering these concentrations:

1. biology,
2. chemistry,
3. geological sciences,
4. mathematics,
5. microbiology,
6. physics, and
7. plant biology.

**Admission.** See “Admission to the Graduate College,” page 84. A prerequisite for admission is the availability of resources for the proposed program and having a faculty member in one of the departments serve as a graduate advisor. The submission of scores on the GRE (verbal, quantitative, and analytical) is required of all applicants.

**Supervisory Committee.** The supervisory committee, consisting of three faculty members, is appointed by the dean of the Graduate College upon the recommendation of the chair of the academic unit in which the graduate advisor serves as a faculty member. The supervisory committee is formed soon after the student has been admitted to the degree program. The graduate advisor and student suggest names of persons to serve on the supervisory committee. The composition of the supervisory committee must reflect the interdisciplinary nature of the program.

**Program of Study.** A program of study is recommended by the supervisory committee after conferring with the student. The minimum number of semester hours required for the degree is 30. More may be required by the supervisory committee depending upon the background of the student and the nature of the proposed program. In some cases undergraduate courses may be required to remove deficiencies.

**Foreign Language Requirements.** None.

**Thesis Requirements.** A thesis is optional.

**Final Examinations.** A final written or oral examination, or both, is required. Each examination is administered by the supervisory committee.

### COURSES

*For course information, refer to the catalog sections of the majors corresponding to the M.N.S.*

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## Nonprofit Leadership and Management

### Certificate Program

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**Robert F. Ashcraft, Director, Center for Nonprofit Leadership and Management**

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The certificate in Nonprofit Leadership and Management, offered through the College of Public Programs, is a graduate program that provides students with an understanding of the nonprofit sector’s role in society and with the skills necessary for effective leadership and management of these organizations. The program is administered through an interdisciplinary faculty committee representing the Department of Recreation Management and Tourism, the School of Public Affairs, and other departments. The objective of this program is to provide students with professional skills needed by leaders in the nonprofit sector, including the understanding of the historical and philosophical context for nonprofit organizations in society, the management of human resources (paid and volunteer), the theory and practice of philanthropy, financial management practices, and other topical content areas.

The certificate program requires a minimum of 15 semester hours of course work. To qualify for the certificate, the student must complete three core classes and two classes from a selected list. A practicum experience is also required of students lacking direct experience in nonprofit sector work. The program is available to students who are pursuing their graduate degree in a chosen field of study and who have expressed interest in pursuing careers in the nonprofit sector. In addition, the program is well suited for working professionals who may or may not be pursuing a graduate degree but who wish to strengthen their skills and connections to the nonprofit community. All applicants must have two years of demonstrable nonprofit experience to obtain the certificate.

For more information, see “Center for Nonprofit Leadership and Management,” page 38, or call 480/965-0607.

### NONPROFIT LEADERSHIP AND MANAGEMENT (NLM)

**NLM 510 Historical and Philosophical Foundations of Nonprofits in America. (3)**

*fall*

Explores the history and role of the nonprofit sector in American society; contemporary issues and delivery systems. Lecture, case study.

**NLM 520 Financial Management in Nonprofit Organizations. (3)**

*spring*

Reviews funding structures utilized by nonprofit organizations; financial tools used by managers; fund raising practices and tools. Lecture, case study.

**NLM 540 Volunteer and Human Resources in Nonprofit Organization. (3)***fall*

Managing the volunteer and paid staff human resources in nonprofit organizations; practices and theories. Lecture, case study.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

## Nursing

### Master's and Certificate Programs

nursing.asu.edu

480/965-3948

NUR 448

**Pamela Kidd, Associate Dean  
for Graduate Programs and Research**

**Professors:** Durand, Kidd, Mattson, Perry, Thurber

**Associate Professors:** Adams, Alpers, Brillhart, Cesarotti, Dirksen, Ismeurt, Killeen, Komnenich, McCarthy, Ruiz

**Assistant Professors:** Link, Long, McGrath, Pickens, Sehested, Shearer, Sousa, Tann, Zunkel

**Clinical Professor:** Bell

**Clinical Associate Professors:** Beck, Fargotstein, Hagler, Jasper, Kastenbaum, Link, Morris, Stillwell, White

**Clinical Assistant Professors:** P. Johnson, W. Johnson, Nunez, Sayles, Wotring

**Instructor:** Rosdahl

The faculty in the College of Nursing offer a graduate program leading to the M.S. degree in Nursing. Concentrations are available in one of the following areas:

1. adult health nursing with options in primary care of chronically ill adults or acute care,
2. community health nursing,
3. community mental health/psychiatric nursing,
4. family health nursing,
5. parent-child nursing with options in childbearing family, nursing of children, and neonatal nursing, and
6. women's health nursing.

The purpose of the graduate program is to provide an academic environment that fosters scholarship, critical thinking, creativity, and prepares nurses for leadership as nurse specialists. The graduate program offers advanced level courses that can be used as a base for doctoral study and for functional role development in teaching.

The master's program is designed to prepare graduates to

1. synthesize advanced knowledge using concepts, theories, principles, and research from nursing, humanities, and sciences to develop advanced nursing practice knowledge which emphasizes the holistic approach;
2. demonstrate leadership, management, and teaching abilities in advanced nursing practice;
3. assume leadership, responsibility, and accountability for holistic therapeutic interventions within or across levels of care for diverse clients including individuals, families, groups, or communities;
4. participate in professional nursing organizations and political arenas;
5. participate in research and utilize research findings;
6. communicate scholarly ideas and professional knowledge to colleagues, other disciplines, and the public;
7. provide leadership in collaboration with clients and other health care professionals in the planning and delivery of holistic health care that is responsive to changing needs and societal trends;
8. examine critically the health of populations and related health care issues; and
9. demonstrate lifelong personal and professional learning.

**Functional Areas.** The curriculum also provides clinical nurse practitioner roles — including adult, pediatrics, women's health, psychiatric, and family as well as clinical nurse specialist in parent-child, adult, community, and community/mental health — for preparation for teaching nursing.

### MASTER OF SCIENCE

See "Master's Degrees," page 93, for general requirements.

**Admission.** See "Admission to the Graduate College," page 84.

Admission to graduate status in the College of Nursing is based upon meeting the following requirements:

1. undergraduate junior or senior GPA equal to 3.00, or a cumulative GPA equal to 3.00 (4.00=A) or higher for any baccalaureate or graduate degree attained;
2. a baccalaureate degree in nursing (or another field) accredited by a nationally recognized accrediting agency;
3. current Arizona license to practice as a registered nurse and/or to enroll in some nursing practicum courses;
4. satisfactory completion of the Graduate Record Examination;
5. one year of work experience in a relevant area of professional nursing (additional years may be required for nurse practitioner roles) before enrolling in specialty concentration clinical courses (not required for community health nursing);

## GRADUATE PROGRAMS AND COURSES

- a descriptive statistics course in a college or university with a grade of "C" or higher, and an inferential statistics course with a grade of "B" or higher;
- three professional recommendations from individuals knowledgeable about the applicant's academic and nursing leadership potential;
- an interview with a representative of the specialty area;
- eligibility for admission to the Graduate College;
- completion of the TOEFL with a score of 550 or higher and of all requirements for the Commission on Foreign Graduate Nursing Schools (CFGNS) if considered an international student; and
- completion of a baccalaureate level health assessment course within the preceding three years may be required for some nurse practitioner concentrations.

Applicants who reside and work, or plan to reside and work, in rural or medically underserved areas are encouraged to apply for admission. Applications to the program are due February 1.

Admission to the RN-B.S.N.-M.S. program is competitive and occurs once a year in January. To be considered for admission to the RN-B.S.N.-M.S. program, an application to the undergraduate professional Nursing major must be submitted. A separate application for admission is required to the graduate program and to the undergraduate professional Nursing major. Admission to the undergraduate program is required before admission to the graduate program. Applications to the RN-B.S.N.-M.S. program are due September 1.

**Supervisory Committee.** The dean of the Graduate College, upon recommendation of the College of Nursing associate dean for Graduate Programs and Research, appoints the supervisory committee. The supervisory committee recommends the program of study, administers any special qualifying examinations, administers the final oral examination, and approves the thesis or the nonthesis option project.

**Program of Study.** The program of study for the M.S. degree consists of a minimum of 40 semester hours for community health areas and from 47 to 53 hours for the nurse practitioner role specialty areas.

The RN-B.S.N.-M.S. program of study consists of at least 30 semester hours; the exact number depends upon specialty concentration and role.

The program of study for the M.S. degree in Nursing requires the completion of a strong research component. This requirement can be accomplished by either of two pathways: (1) completion of the required research course and six hours of thesis or (2) completion of the nonthesis option that includes the required research course (three hours), the research utilization course (three hours), the applied project course (one hour), and a presentation of the completed requirements. The completed project and presentation are evaluated by the student's supervisory committee.

**Required core courses:** NUR 500, NUR 551, NUR 552, NUR 589/593 or NUR 599.

**Flexible core courses:** NUR 510, NUR 521, NUR 524, NUR 528, NUR 553, NUR 554, NUR 526 or NUR 558 or

NUR 559, NUR 561, NUR 527 or NUR 564, NUR 525 or NUR 565 or NUR 582 and NUR 586, NUR 584, CHP 500, CHP 501, CHP 502, and HSA 566.

**Foreign Language Requirements.** None.

**Degree Requirements.** The student must successfully complete the following as defined by the supervisory committee and as approved by the dean of the Graduate College:

- the program of study,
- a comprehensive written examination as required,
- a thesis and final oral examination in defense of the thesis *or* nonthesis option project.

### POST-MASTER'S CERTIFICATE

The College of Nursing offers a post-master's certificate program in all specialty concentrations and in both the Clinical Nurse Specialist and Nurse Practitioner roles on a space available basis.

### RESEARCH ACTIVITY

Research within the College of Nursing focuses on understanding and addressing risk behaviors in vulnerable populations for the purpose of promoting health. Research interests of the College of Nursing faculty may be accessed by visiting [nursing.asu.edu/facultystaff](http://nursing.asu.edu/facultystaff) on the Web.

### COMMUNITY HEALTH PRACTICE (CHP)

#### CHP 500 Foundations for Community Health Practice. (3)

*fall*

Presents the organization, core functions, and essential services of public health. Presentation, discussion, cooperative learning strategies, student presentations. Prerequisite: admission to graduate Nursing program, or admission to the Master of Public Health degree with a concentration in community health practice, or instructor approval.

#### CHP 501 Community Health Assessment and Analysis. (3)

*spring*

Provides theory and practice in community assessment and analysis applicable to community health practice. Presentation, discussion, cooperative learning strategies, group projects. Prerequisite: CHP 500 or instructor approval.

#### CHP 502 Community Health Program Planning and Evaluation. (3)

*fall*

Utilizes planning and evaluation theory in planning programs to meet identified health needs of communities. Presentation, discussion, cooperative learning strategies, group projects. Prerequisites: both CHP 500 and 501 or only instructor approval.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

### NURSING (NUR)

#### NUR 500 Research Methods. (3)

*fall and spring*

Research methods including research conceptualization and design in nursing. Prerequisites: admission to graduate Nursing program; a graduate-level course in inferential statistics prior to enrolling in specialty concentration clinical courses. Corequisite: NUR 551.

#### NUR 501 Advanced Adult Health Assessment/Promotion:

##### Advanced Theory. (4)

*fall*

Expands adult health assessment/promotion skills through knowledge/strategies essential for developing and interpreting data. Lecture, demonstration. Prerequisites: all core and flexible core courses except thesis/project. Corequisite: NUR 580 Advanced Nursing Practicum I: Adult Health Nursing.

**NUR 502 Management and Maintenance of Adults with Chronic Health Alterations: Advanced Theory. (4)***spring*

Includes theory/research that guides the management/maintenance of adults with chronic health alterations. Emphasizes psychophysiological interrelationships of illnesses. Lecture, seminar. Prerequisites: NUR 501; all core and flexible core courses except thesis/project. Pre- or corequisite: NUR 580 Advanced Nursing Practicum II: Adult Health Nursing.

**NUR 503 Management and Maintenance of Adults with Acute Health Alterations: Advanced Theory. (3)***spring of even years*

Emphasizes theoretical research foundations essential for advanced practice involving care of adults with acute episodic alterations in health. Lecture, seminar. Prerequisite: NUR 501. Pre- or corequisite: NUR 580 Advanced Nursing Practicum II: Adult Health Nursing.

**NUR 510 Community/Public Health Nursing Theory and Role. (3)***spring*

Analyzes and synthesizes the theoretical and conceptual basis of community/public health nursing applicable to current and future nursing roles. Lecture, discussion, learner-centered strategies. Prerequisites: CHP 500; NUR 551, 552.

**NUR 521 Community Mental Health/Psychiatric Nursing: Advanced Mental Health Assessment. (3)***fall*

Theories related to holistic health assessment for the promotion of physical/psychological health; develops skill in mental health assessments. Lecture, seminar, lab. Prerequisites: all core and flexible core courses except thesis/project.

**NUR 522 Community Mental Health/Psychiatric Nursing: Advanced Theory I. (3)***fall*

Analyzes issues, theories, and research in restoration and promotion of mental health. Emphasizes developing conceptual framework for psychiatric nursing. Prerequisites: NUR 521; all core and flexible core courses except thesis/project. Corequisite: NUR 580 Advanced Nursing Practicum I: Community Mental Health/Psychiatric Nursing.

**NUR 523 Community Mental Health/Psychiatric Nursing: Advanced Theory II. (3)***spring*

Focuses on development of theoretical basis for intervention and a knowledge base for collaboration and consultation in the mental health area. Prerequisites: NUR 522; all core and flexible core courses except thesis/project. Corequisite: NUR 580 Advanced Nursing Practicum II: Community Mental Health/Psychiatric Nursing.

**NUR 524 Psychoneuroimmunology Approaches to Practice. (3)***summer*

Overview of theories, concepts, and research in psychoneuroimmunology including physiological aspects and application to a holistic nursing model. Seminar. Prerequisite: admission to graduate Nursing program.

**NUR 525 Neonatal/Pediatric Physiology and Embryology. (3)***fall*

Prepares advanced practice nurses to use embryology, genetics, and physiology concepts within the nursing process in the care of pediatric and neonatal patients. Lecture, discussion, participative dialogues, case studies. Prerequisites: a course in undergraduate anatomy and a course in undergraduate physiology.

**NUR 526 Advanced Neonatal Physical Assessment. (4)***fall*

Develops assessment skills related to neonate/infant, including history-taking, physical, developmental, behavioral, cultural, and genetics assessment to provide comprehensive advanced practice neonatal nursing care. Lecture, seminar, discussion, case studies. Fee. Prerequisite: instructor approval. Corequisite: NUR 525.

**NUR 527 Neonatal and Pediatric Pharmacology in Nursing Practice. (3)***spring*

Examines and discusses the rationale, action, and therapeutic effect for using each class of medications employed in neonatal and pediatric health care. Lecture, seminar, discussion, case studies, clinical. Pre- or corequisites: both NUR 525 and 526 (or 558) or only instructor approval.

**NUR 528 Advanced Developmental and Family-Centered Nursing Care. (4)***spring*

Provides the foundation for providing advanced nursing care of children that is developmentally supportive, family centered, and culturally competent. Lecture, seminar, discussion, skills laboratory, clinical. Fee. Pre- or corequisites: both NUR 525 and 526 (or 558) or only instructor approval.

**NUR 531 Nursing of Children: Advanced Theory I. (3)***fall*

Focuses on current practices, research, and issues related to health promotion and disease prevention for children and adolescents. Lecture, seminar. Prerequisites: all core and flexible core courses except thesis/project. Corequisite: NUR 580 Advanced Nursing Practicum I: Parent-Child Nursing with Options in Childbearing Family, Nursing of Children, and Neonatal Nursing.

**NUR 532 Nursing of Children: Advanced Theory II. (3)***spring*

Focuses on concepts, theories, and research as a basis for strategies related to management of illness and health maintenance for children. Lecture, seminar. Prerequisites: NUR 531; all core and flexible core courses except thesis/project. Corequisite: NUR 580 Advanced Nursing Practicum II: Parent-Child Nursing with Options in Childbearing Family, Nursing of Children, and Neonatal Nursing.

**NUR 533 Nursing of Children with Special Needs: Advanced Theory. (3)***spring*

Focuses on concepts, theories, and research related to acute and chronic health deviations of children. Lecture, seminar. Prerequisites: NUR 531 (or instructor approval); all core and flexible core courses except thesis/project. Corequisite: NUR 580 Advanced Nursing Practicum II: Parent-Child Nursing with Options in Childbearing Family, Nursing of Children, and Neonatal Nursing.

**NUR 534 Women's Health: Advanced Theory I. (4)***fall*

Focuses on theories, principles, and research related to managing the health of normal perinatal women and families. Cooperative learning strategies. Prerequisites: all core and flexible core courses except thesis/project. Corequisite: NUR 580 Advanced Nursing Practicum I: Women's Health Nursing.

**NUR 535 Women's Health: Advanced Theory II. (4)***spring*

Focuses on management of nursing care for high-risk perinatal women and women with common health problems. Cooperative learning strategies. Prerequisites: NUR 534; all core and flexible core courses except thesis/project. Corequisite: NUR 580 Advanced Nursing Practicum II: Women's Health Nursing.

**NUR 551 Theoretical Foundations of Advanced Practice Nursing. (3)***fall and spring*

Facilitates exploration and examination of the foundations of advanced nursing practice. Lecture, seminar. Prerequisite: admission to graduate Nursing program.

**NUR 552 Health Care Issues and Systems. (3)***fall and spring*

Analyzes organization, financing, service delivery, and outcomes of the health system. Emphasizes policy issues, roles, and challenges for nurses. Lecture, seminar. Prerequisite: admission to graduate Nursing program.

**NUR 553 Life Span Development. (3)***spring*

Critical examination of concepts, theories, issues, and research related to developmental periods throughout the life span. Analyzes biological and health, cognitive, psychological, and sociocultural influences. Lecture, discussion. Prerequisite: admission to graduate Nursing program.

**NUR 554 Population-Based Health Care. (3)***fall and spring*

Identification and assessment of specific community health needs and health care patterns of target populations. Addresses promotion, protection, and improvement of health when planning health care services. Lecture, seminar. Prerequisite: admission to graduate Nursing program.

## GRADUATE PROGRAMS AND COURSES

### **NUR 558 Advanced Pediatric Health Assessment. (3)**

*spring*

Expansion of basic health assessment skills and development of clinical problem-solving skills for advanced practice nurses. Includes assessments of infants, children, and adolescents. Lecture, lab. Prerequisites: admission to graduate Nursing program; undergraduate health assessment within the last five years.

### **NUR 559 Advanced Health Assessment. (3)**

*spring*

Expansion of basic health assessment skills and development of clinical problem-solving skills for advanced practice nurses. Includes assessments of infants, children, adolescents, and adults. Lecture, lab. Fee. Prerequisites: admission to graduate Nursing program; undergraduate health assessment within the last five years.

### **NUR 561 Advanced Practice Nursing Role. (2)**

*summer*

Focuses on the examination and implementation of the role of the advanced practice nurse, emphasizing major components and sub-components of the role. Lecture, seminar. Prerequisite: admission to graduate Nursing program or instructor approval.

### **NUR 562 Family Nurse Practitioner Advanced Theory I: Health Promotion, Management, and Maintenance. (4)**

*fall*

First didactic role specialty course. Focuses on concepts and strategies to promote, manage, and maintain health of child, adult, and family. Prerequisites: all core and flexible core courses except thesis/project. Corequisite: NUR 580 Advanced Nursing Practicum I: Family Health Nursing.

### **NUR 563 Family Nurse Practitioner Advanced Theory II: Health Promotion, Management, and Maintenance. (4)**

*spring*

Second didactic role specialty course utilizing knowledge from previous courses to formulate therapeutic promotion, management, and maintenance for individuals across the life span. Prerequisites: NUR 562; all core and flexible core courses except thesis/project. Corequisite: NUR 580 Advanced Nursing Practicum II: Family Health Nursing.

### **NUR 564 Applied Pharmacotherapeutics for Advanced Practice. (3)**

*spring*

Life span course for advanced nurse practitioners to expand knowledge of pharmacotherapeutic concepts and principles. Lecture, discussion, case studies. Prerequisite: admission to graduate Nursing program.

### **NUR 565 Applied Physiology/Pathophysiology in Advanced Practice. (3)**

*spring*

Advanced nurse practitioner course designed to expand previously acquired anatomy and physiology knowledge and discern pathological alterations across the life span. Lecture, seminar, case studies. Prerequisites: admission to graduate Nursing program; undergraduate anatomy and physiology.

### **NUR 566 Pediatric Physiology/Pathophysiology. (3)**

*spring*

Analyzes the patterns of heredity, cellular differentiation, and the development of systems in the infant to adolescent. Prerequisite: admission to graduate Nursing program.

### **NUR 571 Teaching in Nursing Programs. (3)**

*selected semesters*

Analyzes theories, issues, and research related to teaching in nursing. Focuses on the process of teaching/learning. Seminar, cooperative learning. Prerequisite: graduate standing.

### **NUR 578 Gestalt Therapy I. (3)**

*fall*

Introduces theory and methodology of Gestalt therapy and its uses for mental health promotion and restoration.

### **NUR 579 Gestalt Therapy II. (3)**

*spring*

Focuses on further development of Gestalt therapy and its application in working with various client populations. Prerequisite: NUR 578.

### **NUR 580 Practicum. (1–12)**

*selected semesters*

Topics may include the following:

- **Advanced Nursing Practicum I: Adult Health Nursing. (2–6)**  
*fall and spring*  
Clinical application of theories, concepts, and principles in areas of concentration. Conferences. Fee. Prerequisite: admission to graduate Nursing program. Corequisite: NUR 501 or 502 or 503.
- **Advanced Nursing Practicum II: Adult Health Nursing. (2–6)**  
*fall and spring*  
Clinical application of theories, concepts, and principles in areas of concentration. Conferences. Fee. Prerequisite: admission to graduate Nursing program. Corequisite: NUR 501 or 502 or 503.
- **Advanced Nursing Practicum: Community Health Nursing. (2–6)**  
*fall and spring*  
Clinical application of theories, concepts, and principles in areas of concentration. Conferences. Prerequisite: admission to graduate Nursing program. Corequisite: NUR 510.
- **Advanced Nursing Practicum I: Community Mental Health/Psychiatric Nursing. (2–6)**  
*fall and spring*  
Clinical application of theories, concepts, and principles in areas of concentration. Conferences. Prerequisite: admission to graduate Nursing program. Corequisite: NUR 522 or 523.
- **Advanced Nursing Practicum II: Community Mental Health/Psychiatric Nursing. (2–6)**  
*fall and spring*  
Clinical application of theories, concepts, and principles in areas of concentration. Conferences. Prerequisite: admission to graduate Nursing program. Corequisite: NUR 522 or 523.
- **Advanced Nursing Practicum I: Family Health Nursing. (2–6)**  
*fall and spring*  
Clinical application of theories, concepts, and principles in areas of concentration. Conferences. Fee. Prerequisite: admission to graduate Nursing program. Corequisite: NUR 562 or 563.
- **Advanced Nursing Practicum II: Family Health Nursing. (2–6)**  
*fall and spring*  
Clinical application of theories, concepts, and principles in areas of concentration. Conferences. Fee. Prerequisite: admission to graduate Nursing program. Corequisite: NUR 562 or 563.
- **Advanced Nursing Practicum I: Parent-Child Nursing with Options in Childbearing Family, Nursing of Children, and Neonatal Nursing. (2–6)**  
*fall and spring*  
Clinical application of theories, concepts, and principles in areas of concentration. Conferences. Fee. Prerequisite: admission to graduate Nursing program. Corequisite: NUR 531 or 532.
- **Advanced Nursing Practicum II: Parent-Child Nursing with Options in Childbearing Family, Nursing of Children, and Neonatal Nursing. (2–6)**  
*fall and spring*  
Clinical application of theories, concepts, and principles in areas of concentration. Conferences. Fee. Prerequisite: admission to graduate Nursing program. Corequisite: NUR 531 or 532.
- **Advanced Nursing Practicum I: Women's Health Nursing. (2–6)**  
*fall and spring*  
Clinical application of theories, concepts, and principles in areas of concentration. Conferences. Prerequisite: admission to graduate Nursing program. Corequisite: NUR 534 or 535.
- **Advanced Nursing Practicum II: Women's Health Nursing. (2–6)**  
*fall and spring*  
Clinical application of theories, concepts, and principles in areas of concentration. Conferences. Prerequisite: admission to graduate Nursing program. Corequisite: NUR 534 or 535.
- **Practicum (Electives). (1–4)**  
*selected semesters*  
Clinical application of theories, concepts, and principles such as health promotion, health management, health maintenance, teaching, management, and special clinical studies. Fee.
- **Practicum for Teaching. (2–6)**  
*selected semesters*  
Prerequisites: NUR 571, 591.

**NUR 582 Advanced Human Physiology. (3)***fall*

Analyzes major theories and concepts of human physiology. Explores interrelationship of physiology and health. Prerequisite: admission to graduate Nursing program.

**NUR 584 Community Health Nursing Internship. (3)***spring*

Students operationalize community health nursing/public health content in leadership roles in a variety of community agencies. Clinical internship. Prerequisites: NUR 510 and 580 Advanced Nursing Practicum: Community Health Nursing.

**NUR 585 Stress Reduction. (3)***selected semesters*

Theory, application, and evaluation of mind/body relaxation methods, including physiological effects. Emphasizes research findings. Daily student practice. Prerequisite: graduate standing or instructor approval.

**NUR 586 Advanced Pathophysiology. (3)***spring*

Manifestation of altered human physiology and disease. Uses systems theory to analyze the relationships of disease and physiology. Prerequisites: NUR 582; admission to graduate Nursing program.

**NUR 589 Research Utilization. (3)***fall and spring*

Emphasizes the synthesis and application of research to an identified clinical nursing problem. Prerequisites: all core and flexible core courses except thesis/project. Corequisite: NUR 593.

**NUR 590 Reading and Conference. (1–12)***selected semesters*

Independent study in which a student meets regularly with a faculty member to discuss assignments such as intensive reading in a specialized area, writing synthesis of literature on a specific topic, or writing literature review of a topic. Prerequisite: instructor approval.

**NUR 591 Seminar. (2–4)***selected semesters*

Advanced topics, including curriculum development and health promotion. Prerequisite: instructor approval in selected courses.

**NUR 593 Applied Project. (1)***fall and spring*

Preparation of a supervised applied project that is a graduation requirement in some professional majors. Prerequisites: all core and flexible core courses. Corequisite: NUR 589.

**NUR 598 Special Topics. (1–4)***selected semesters*

Special study, including issues in health care and organizations, management in nursing, ethical issues, and clinical nurse specialist role.

Topics may include the following:

- Advanced Neonatal Theory I. (4)

*fall*

- Advanced Neonatal Theory II. (3)

*spring*

- Nursing of Children with Development Disabilities. (3)
- School Nursing Practice. (3)

**NUR 599 Thesis. (1–6)***fall, spring, summer*

Research proposal development, data collection and analysis, thesis writing, and thesis oral defense. Requires six hours. Prerequisites: all core and flexible core courses.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

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## Nutrition

**Master's Program**

[www.east.asu.edu/ecollege/nutrition](http://www.east.asu.edu/ecollege/nutrition)

480/727-1728

HSC 1386

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**Linda A. Vaughan, Chair**

**Professors:** Johnston, Vaughan**Assistant Professors:** Hampl, Hutchins**Senior Lecturer:** Martin**Lecturer:** Dixon

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The faculty in the Department of Nutrition, at ASU East, offer a graduate program leading to a M.S. degree in Nutrition. The department also offers a Dietetic Internship program, which is currently granted accreditation by the

COMMISSION ON ACCREDITATION FOR  
DIETETICS EDUCATION OF THE AMERICAN  
DIETETIC ASSOCIATION  
216 W JACKSON BLVD  
CHICAGO IL 60606-6995

The commission can be reached by phone at 312/899-0040, ext. 5400.

**Admission.** Applications for admission and graduate assistantships are accepted until February 1 preceding the fall semester to which the applicant is seeking admission. In addition to meeting Graduate College requirements, students must submit an official record of their scores on the Graduate Record Examination (verbal, quantitative, and analytical), three letters of recommendation, a résumé of employment and academic experiences, and the completed departmental Supplementary Information Form. Students wishing to be considered for graduate assistantships must also complete the Graduate College and departmental forms. The prerequisites for graduate work in Nutrition are as follows: anatomy and physiology with laboratory, biochemistry with laboratory, general chemistry with laboratory, general nutrition, introductory statistics, microbiology with laboratory, and organic chemistry with laboratory. Admission procedures for the Dietetic Internship are explained below.

**Program of Study.** The program of study consists of a minimum of 31 semester hours. Required courses are NTR 500 Research Methods in Nutrition (or an equivalent course, with advisor approval), three to six semester hours of 500-level statistics courses approved by an advisor, six semester hours of thesis/research credit, a one-semester-hour departmental seminar (NTR 591 S: Recent Developments in Food and Nutrition), and six semester hours of nutrition seminars

## GRADUATE PROGRAMS AND COURSES

selected from NTR 531, 532, and/or 598. Students completing the Dietetic Internship must also complete six semester hours of NTR 580 Dietetics Practicum; only three semester hours of NTR 580 may be applied toward the M.S. degree. Additional courses may be selected upon consultation with an advisor.

**Foreign Language Requirements.** None.

**Thesis Requirements.** A thesis is required.

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

### RESEARCH ACTIVITY

The faculty in the Department of Nutrition are engaged in a broad range of research activities. Undergraduate students are encouraged to collaborate with faculty and graduate students in the research process. Department faculty are well recognized for their research in the areas of Vitamin C metabolism, nutrition and exercise, the nutrient intakes of children and young adults, and the nutritional status of free-living and homebound elderly. Nutrition faculty conduct controlled metabolic feeding studies, investigate food product stability, analyze national food and nutrient data sets, and assess the nutritional status of children and adults. Interdisciplinary research is conducted in conjunction with agribusiness, anthropology, exercise and wellness, immunology, nursing, and other faculty. For more information, access the Department of Nutrition Web site at [www.east.asu.edu/ecollege/nutrition](http://www.east.asu.edu/ecollege/nutrition).

**Dietetic Internship.** Admission to the Dietetic Internship is limited to students with regular or unconditional admission to the Department of Nutrition's graduate program and submission of an official Verification Statement documenting successful completion of a Didactic Program in Dietetics (DPD). If DPD requirements have not been met at the time application to the Dietetic Internship is made, students must submit an Intent to Complete form and all DPD courses must be completed before entering the internship. Students must provide documentation that a minimum of 150 hours of clinical experience has been completed within the past five years. The Dietetic Internship is limited to students enrolled in the ASU East Master's Program in Nutrition, and therefore does not participate in computer matching. Students must complete both the M.S. degree requirements and the Internship practicum requirements to satisfy the Dietetic Internship requirements and establish eligibility to sit for the Registration Examination for Dietitians.

### NUTRITION (NTR)

#### **NTR 440 Advanced Human Nutrition I. (3)**

*fall*  
Metabolic reactions and interrelationships of vitamins, minerals, and water. Prerequisites: BIO 202 and CHM 231 and NTR 241 (or their equivalents).

#### **NTR 441 Advanced Human Nutrition II. (3)**

*spring*  
Metabolic reactions and interrelationships of carbohydrate, lipid, and protein. Prerequisites: BCH 361 and BIO 202 and NTR 241 (or their equivalents).

#### **NTR 442 Experimental Foods. (3)**

*fall and spring*  
Food product development techniques, food evaluation and testing, and investigation of current research into food composition. 2 hours lecture, 3 hours lab. Fee. Prerequisites: CHM 231; NTR 142.

#### **NTR 444 Medical Nutrition Therapy. (3)**

*spring and summer*  
Principles of medical nutrition therapy for prevention and treatment of disease and promotion of health. Prerequisites: BIO 201 and 202 and NTR 241 (or their equivalents).

#### **NTR 445 Quantity Food Production. (3)**

*fall and spring*  
Standardized methods of quantity food preparation, operation of institutional equipment, institutional menu planning, quantity food experiences. Lecture, lab, possible field trips. Fee. Prerequisites: NTR 100 (or 241) and 344 (or their equivalents).

#### **NTR 446 Human Nutrition Assessment Lecture/Laboratory. (3)**

*fall and spring*  
Clinical and biochemical evaluation of nutritional status. 2 hours lecture, 3 hours lab. Fee. Prerequisites: BCH 361, 367; NTR 440 (or 441).

#### **NTR 448 Community Nutrition. (3)**

*fall and spring*  
Food-related behaviors; organization and delivery of nutrition services; program design, implementation, and evaluation strategies; nutrition assessment of populations. Prerequisite: NTR 241 (or its equivalent).

#### **NTR 450 Nutrition in the Life Cycle I. (3)**

*fall*  
Emphasizes nutritional needs and problems during pregnancy, lactation, infancy, and childhood. Prerequisite: NTR 100 or 241 (or its equivalent).

#### **NTR 451 Nutrition in the Life Cycle II. (3)**

*spring*  
Nutritional requirements and nutrition-related disorders of adolescence, middle adulthood, and later life. Prerequisite: NTR 100 or 241 (or its equivalent).

#### **NTR 500 Research Methods in Nutrition. (3)**

*fall*  
Experimental design; methods of data collection, laboratory analyses, and statistical analyses; development of thesis proposal. Lecture, lab. Fee. Prerequisites: a course each in advanced nutrition, biochemistry, and statistics.

#### **NTR 531 Recent Developments in Nutrition. (1)**

*fall and spring*  
Selected topics addressing current issues in nutrition research. Prerequisites: a course each in advanced nutrition and biochemistry.

#### **NTR 532 Current Research in Nutrition. (3)**

*spring*  
Vitamins and minerals. Prerequisites: a course each in advanced nutrition and biochemistry.

#### **NTR 540 Advanced Micronutrient Metabolism. (3)**

*fall*  
Metabolism of vitamins and minerals, primarily as applied to humans, with research literature emphasized. Prerequisites: a course each in basic nutrition and biochemistry.

#### **NTR 541 Advanced Macronutrient Metabolism. (3)**

*spring*  
Metabolism of protein, fat, and carbohydrate, primarily as applied to humans, with research literature emphasized. Prerequisites: a course each in basic nutrition and biochemistry.

#### **NTR 542 Advanced Food Product Development. (3)**

*fall and spring*  
Food product development techniques, food evaluation and testing, and investigation of current research into food composition. 2 hours lecture, 3 hours lab. Fee. Prerequisites: CHM 231 and NTR 142 (or their equivalents).

#### **NTR 544 Therapeutic Nutrition. (3)**

*spring and summer*  
Current theories of the nutritional prevention or treatment of various diseases. Prerequisites: a course each in basic nutrition, introduction to diet therapy, and physiology.

**NTR 545 Recent Developments in Institutional Feeding. (3)***fall and spring*

Current practices in institutional feeding, including supervised practicum with local quantity food operation. 1 hour lecture, 6 hours lab. Fee. Prerequisites: NTR 142 and 344 (or their equivalents).

**NTR 546 Assessment Techniques in Nutrition. (3)***fall and spring*

Clinical and biochemical evaluation of nutritional status. 2 hours lecture, 3 hours lab. Fee. Prerequisites: a course each in advanced nutrition, biochemistry, and physiology.

**NTR 548 Nutrition Program Development. (3)***fall and spring*

Planning, development, implementation, and evaluation of community nutrition programs, including the process of grant applications. Prerequisites: a course each in basic nutrition and sociology.

**NTR 550 Advanced Maternal and Child Nutrition. (3)***fall*

In-depth review of metabolic characteristics and nutritional needs of the pregnant woman, lactating woman, infant, and child. Prerequisites: a course each in basic nutrition, biochemistry, and physiology.

**NTR 551 Advanced Geriatric Nutrition. (3)***spring*

In-depth review of metabolic characteristics and nutritional requirements of the elderly. Prerequisites: a course each in basic nutrition, biochemistry, and physiology.

**NTR 580 Dietetics Practicum. (3–9)***fall, spring, summer*

Structured practical experience in the Dietetic Internship, supervised by practitioners with whom the student works closely. Practicum. Prerequisite: acceptance into the Dietetic Internship.

**NTR 591 Seminar. (1–12)***selected semesters*

Topics may include the following:

- Recent Developments in Food and Nutrition. (1)

**NTR 592 Research. (1–12)***selected semesters***NTR 593 Applied Project. (1–12)***selected semesters***NTR 594 Conference and Workshop. (1–12)***selected semesters***NTR 598 Special Topics. (3)***fall and spring*

In-depth review of recent research in areas including nutrition and exercise, nutrition and immunology, energy balance, vegetarianism, nutritional pathophysiology. Fee. Prerequisites: a course each in advanced nutrition, biochemistry, and physiology.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

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## Performance

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See "Music," page 273.

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## Philosophy

**Master's and Doctoral Program**

[www.asu.edu/philosophy](http://www.asu.edu/philosophy)

480/965-3394

PS A524

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**Brad Armendt, Chair**

**Regents' Professors:** Maienschein, Murphy

**Professors:** Cohen, Creath, Fitch, French, Humphrey, White

**Associate Professors:** Armendt, Blackson, de Marneffe, Guleserian, Kobes, McGregor, Reynolds

**Assistant Professor:** Devlin

**Lecturer:** Bolton

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The faculty in the Department of Philosophy offer a graduate program leading to the M.A. or Ph.D. degree in Philosophy. For the specific requirements of the Ph.D., contact the department.

**MASTER OF ARTS**

See "Master's Degrees," page 93, for general requirements.

**Prerequisites.** At least 15 semester hours of upper-division course work in philosophy, including history of ancient and modern philosophy, epistemology, metaphysics, and the equivalent of PHI 333 Introduction to Symbolic Logic are required. No course credits in which a grade of less than "B" has been earned may count toward meeting this 15-semester-hour requirement. Persons otherwise qualified for admission but lacking the above prerequisites may make up this deficiency by enrolling as a nondegree graduate student and taking those philosophy courses necessary to complete the prerequisite. If some or most of the prerequisites have already been met, the student may be admitted into the program under "provisional status" or under "regular status with deficiencies." All applicants for admission to the program must submit scores for the general section of the Graduate Record Examination.

**Admission.** All applications for admission to the M.A. degree program in Philosophy must be accompanied by complete transcripts, the applicant's score in the GRE aptitude exam, three letters of recommendation from persons qualified to judge the applicant's potential for graduate work in philosophy, a sample of philosophical writing, and a statement of purpose.

**Program of Study.** The M.A. degree program in Philosophy is designed to prepare students either to teach philosophy at the community college level, to enter doctoral programs in philosophy at other institutions, or to be employed



## GRADUATE PROGRAMS AND COURSES

in any areas that require critical, analytical thinking (such as medicine, law, government, or publishing). The program seeks to maintain a balance between a breadth of course offerings in the traditional areas of philosophy—metaphysics, ethics, epistemology, logic, and history of philosophy—and opportunities for study in current philosophical developments, such as the philosophy of science, philosophy of language, and philosophical psychology. The program of study includes at least 30 semester hours of approved graduate-level courses, not including PHI 599 Thesis. An additional six hours of PHI 599 Thesis is required. The details of each student's program are worked out with the director of graduate studies.

**Course Requirements.** Each student is required to take an approved graduate-level course of three semester hours or more in each of the following areas and to obtain at least a "B" in each course: metaphysics/epistemology, value theory and logic; and any two of the following: history of early philosophy, history of modern philosophy, and history of contemporary philosophy.

**Foreign Language Requirements.** None.

**Thesis Requirements.** A thesis is required. This written work must demonstrate the ability to carry out independent research in philosophy.

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

### DOCTOR OF PHILOSOPHY

See "Doctoral Degrees," page 95, for general requirements.

**Prerequisites.** At least 15 semester hours of upper-division course work in philosophy, including history of ancient and modern philosophy, epistemology, metaphysics, and the equivalent of PHI 333 Introduction to Symbolic Logic are required. No course credits in which a grade of less than "B" has been earned may count toward meeting this 15-semester-hour requirement. If some or most of the prerequisites have already been met, the student may be admitted into the program under "provisional status" or under "regular status with deficiencies."

**Admission.** All applications for admission to the Ph.D. degree program in Philosophy must be accompanied by complete transcripts, the applicant's score in the GRE aptitude exam, three letters of recommendation from persons qualified to judge the applicant's potential for graduate work in philosophy, a sample of philosophical writing, and a statement of purpose.

**Program of Study.** The Ph.D. degree program in Philosophy is designed to prepare students for careers as philosophers and teachers of philosophy, and in areas that may benefit from advanced training in philosophy, such as law, civil service, and publishing. The program of study includes 60 semester hours (30 beyond the M.A.) of graduate credit plus 24 semester hours of research and dissertation. The student's program of study is selected by the student in consul-

tation with the graduate director and the supervisory committee and is approved by the supervisory committee.

**Course Requirements.** To ensure breadth in the traditional areas of philosophy, students are required to pass these courses with a grade of "B" or higher:

1. two graduate courses in history of philosophy in two different areas chosen from ancient, modern, and contemporary;
2. two graduate courses in value theory;
3. four graduate courses in metaphysics and epistemology (including areas such as philosophy of language, philosophy of science, and philosophy of mind); and
4. one advanced course in symbolic logic (at the 400 or 500 level) (students may satisfy the logic requirement by examination).

**Foreign Language Requirement.** None.

**Comprehensive Examination.** Students will be examined in their area of specialization and competence. The written and oral examinations are based on a bibliography compiled by the student and approved by the student's advisory committee. Normally these examinations are taken after the student has completed at least 60 hours of graduate course work.

**Dissertation Prospectus.** Each doctoral candidate will prepare a prospectus of four to seven pages for the dissertation. The format and design of the prospectus will be determined by the candidate and committee chair. The prospectus should include a

1. thesis statement,
2. discussion of relevant literature,
3. discussion of the approach to the project, and
4. bibliography.

**Dissertation.** A dissertation based on original research is required. Research for the dissertation is supervised by a committee of at least three faculty members, appointed by the graduate director in consultation with the student. Students must enroll for a minimum of 12 semester hours of Research or Dissertation credit after admission to candidacy.

**Final Examination.** An oral examination in defense of the dissertation is required.

### RESEARCH ACTIVITY

The department offers a solid program in traditional and contemporary philosophy. General areas of research include ethics, political philosophy, metaphysics, epistemology, philosophy of law, philosophy of science, philosophy of language, philosophy of religion, and the history of philosophy. The topics treated in recent and current faculty research include moral psychology and moral emotions, environmental ethics, feminist analysis of law, liberty and paternalism, causation, rational choice theory, contextualism in epistemology, perceptual knowledge, the nature of consciousness,

the role of the *a priori* in science and philosophy, truth, reference, externalist theories of mental content, and free will.

### PHILOSOPHY (PHI)

#### PHI 401 Rationalism. (3)

*selected semesters*

Examines classical philosophical rationalism, as in Descartes, Spinoza, Malebranche, or Leibniz. Contemporary rationalist thought may also be examined. Prerequisites: PHI 302 and 305 (or 309 or 312 or 316 or 317).

#### PHI 402 Empiricism. (3)

*selected semesters*

Examines representatives of either classical or contemporary philosophical empiricism, e.g., Bacon, Hobbes, Locke, Butler, Berkeley, Reid, Hume, Mill, Carnap, and Ayer. Prerequisites: PHI 302 and 305 (or 309 or 312 or 316 or 317).

#### PHI 403 Contemporary Analytic Philosophy. (3)

*once a year*

Aims and methods of such 20th-century philosophers as Frege, Moore, Russell, Wittgenstein, Carnap, Ayer, Wisdom, Ryle, Austin, Strawson, Quine, and Sellars, with application to metaphysics and epistemology. Prerequisites: PHI 302 and 312 (or 314 or 315 or 316 or 317 or 401 or 402).

#### PHI 413 Advanced Symbolic Logic. (3)

*selected semesters*

Properties of formal systems axiomatizing propositional and 1st-order predicate logic. May also include modal logic, number theory, and limits of logicism. Prerequisite: PHI 333.

#### PHI 420 Topics in Philosophy. (3)

*once a year*

Course descriptions on file in department. May be repeated for credit.

Topics may include the following:

- History of Philosophy
- Metaphysics/Epistemology
- Philosophy of Language/Logic
- Philosophy of Science
- Value Theory

Prerequisite: a relevant upper-division PHI course or instructor approval.

#### PHI 590 Reading and Conference. (1–12)

*selected semesters*

#### PHI 591 Seminar. (1–12)

*once a year*

Topics may include the following:

- Aesthetics. (1–3)
- Epistemology. (1–3)
- Ethics. (1–3)
- History of Philosophy. (1–3)
- Logic. (1–3)
- Metaphysics. (1–3)
- Philosophy of Language. (1–3)
- Philosophy of Law. (1–3)
- Philosophy of Science. (1–3)
- Social and Political Philosophy. (1–3)

Prerequisite: Philosophy graduate student or instructor approval.

#### PHI 592 Research. (1–15)

*selected semesters*

#### PHI 599 Thesis. (1–12)

*fall and spring*

#### PHI 790 Reading and Conference. (1–12)

*selected semesters*

#### PHI 792 Research. (1–15)

*selected semesters*

#### PHI 799 Dissertation. (1–15)

*selected semesters*

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

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## Physical Education

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See "Master of Physical Education," page 213.

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## Physics

### Master's and Doctoral Programs

[phy.asu.edu](http://phy.asu.edu)

480/965-0355

PS F470

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Barry G. Ritchie, Chair

**Regents' Professors:** Smith, Spence, Starrfield

**Professors:** Alarcon, Bennett, Burstein, Chamberlin, Comfort, Cowley, Doak, Dow, Hester, Kaufmann, Lindsay, Menéndez, Page, Ponce, Rez, Ritchie, Sankey, Scheinfein, Schmidt, Tillery, Tsen, Tsong, Venables, Windhorst, Wyckoff

**Associate Professors:** Aannestad, Culbertson, Drucker, Herbots, Marzke

**Assistant Professors:** Lebed, Shumway

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The faculty in the Department of Physics and Astronomy offer graduate programs leading to the M.S. and Ph.D. degrees in Physics. In the M.S. program, options are available in physics, physics with an emphasis in astronomy, interdisciplinary physics, technical physics, or physics teaching. In the Ph.D. program, options are available in physics, physics with an emphasis in astronomy, or applied physics. Within the physics program, students may pursue a wide range of studies, including an emphasis in biophysics, condensed matter and materials physics, physics education, or subatomic physics.

The faculty in the Department of Physics and Astronomy also participate in the program leading to the Master of Natural Science degree (see "Natural Science," page 279) when one of the concentrations is physics, and in the interdisciplinary program leading to the Ph.D. degree in the Science and Engineering of Materials (see "Science and Engineering of Materials," page 312).

Students admitted to the Master of Education degree program with a major in Secondary Education may elect physics or science education as the subject matter field. A Doctor of Education degree program option is also available. The M.Ed. (see "Master of Education," page 181) and Ed.D. (see "Doctor of Education," page 182) are offered and administered through the College of Education.

The master's and doctoral programs are designed to prepare students for professional research careers in

## GRADUATE PROGRAMS AND COURSES

governmental, industrial, or academic institutions and for teaching at the university, college, or secondary school levels.

An evaluation of the progress of all graduate students is made during the spring semester by the Graduate Program Committee. Students whose progress is considered to be unsatisfactory are placed on probation. Failure to maintain a GPA of 3.00 in courses taken while enrolled as a graduate student, exclusive of research, thesis, and dissertation, is an indication of unsatisfactory progress and may result in dismissal from the program.

Courses can include up to six semester hours of 400-level courses (see “Graduate Credit Courses,” page 89). Timely attempts at examination are also required.

Teaching experience in undergraduate physics and astronomy laboratories and recitations is valuable training for graduate students and is considered part of the graduate program.

Departmental colloquia are an integral part of the graduate program. Regular attendance at colloquia is expected of all graduate students intending to earn graduate degrees.

### MASTER OF SCIENCE

See “Master’s Degrees,” page 93, for general requirements.

**Admission.** To be admitted without deficiencies, entering graduate students should have adequate undergraduate preparation equivalent to an undergraduate major of 30 semester hours in physics and 20 semester hours in mathematics. Courses in analytic mechanics, electromagnetism, and modern physics, including quantum mechanics, are particularly important. Students applying for admission must submit scores for the verbal, quantitative, and analytical sections of the Graduate Record Examination (GRE).

Applicants for financial support must submit a score on the physics advanced examination of the GRE. Subsequent financial support in the form of teaching or research assistantships is contingent upon satisfactory performance in course work, timely completion of the final examination for the M.S. degree as described below, and need and availability of such support. Students on probation are offered financial support only under exceptional circumstances.

**Program of Study.** The faculty in the Department of Physics and Astronomy offer the M.S. degree, emphasizing either physics solely or in combination with one of the following fields:

1. astronomy and astrophysics,
2. interdisciplinary physics (e.g., with chemistry),
3. technical physics, or
4. physics teaching.

A supervisory committee is formed for each student, usually during the first year of study. In each case an appropriate program of study is selected with the approval of the supervisory committee. A research project resulting in a thesis is required of all students enrolled in the M.S. program.

*Physics.* An individual program of study, including courses in physics, astronomy, mathematics, or related subjects, is selected with the approval of the supervisory committee to

make up a coherent program of graduate study. The courses and research project are to be conducted primarily within the Department of Physics and Astronomy.

*Astronomy and Astrophysics.* The AST graduate courses are taken in addition to the required graduate physics courses for the M.S. program. The research project must be in the area of astronomy and astrophysics, conducted under the supervision of one or more faculty members of the Department of Physics and Astronomy who specialize in this subject.

*Interdisciplinary Physics.* The courses taken are approximately half in physics and half in some other subject area. The research project must be in an interdisciplinary area and conducted under the joint supervision of one faculty member from the Department of Physics and Astronomy and one faculty member from another department.

*Technical Physics.* The research project involves active collaboration with an industrial or government laboratory under the supervision of a faculty member from the Department of Physics and Astronomy and may be conducted either in the Department of Physics and Astronomy or in the outside laboratory. At least half the courses taken must be in physics.

*Physics Teaching.* The course of study and research are designed to prepare students for a career in physics teaching, with appropriate modifications for teaching at the high school or community college level. At least half the courses taken must be in physics. Students participate in directed, evaluated teaching experiences.

**Foreign Language Requirements.** None.

**Thesis Requirements.** A thesis is required of all students obtaining the M.S. degree. Every student must complete at least six semester hours of PHY 592 or PHY 599. However, no more than nine semester hours in these courses can be counted toward the 30 semester hours required for the M.S. degree.

**Final Examinations.** The final examination for the M.S. degree is an oral examination on the subject of the student’s thesis and on graduate course work taken.

### DOCTOR OF PHILOSOPHY

See “Doctor of Philosophy,” page 96, for general requirements.

**Admission.** This program is designed for students with a high-level of ability who show promise for independent research. An applicant holding a baccalaureate degree should have the same undergraduate preparation as for admission to the master’s program. An applicant presenting acceptable graduate credit, earned at this or another institution must demonstrate mastery of this material, see “Written Comprehensive Examination” and “Oral Comprehensive Examination,” page 291.

Students applying for admission must submit scores for the verbal, quantitative, and analytical sections of the GRE.

Applicants for financial support must submit a score on the physics advanced examination of the GRE. Subsequent financial support in the form of teaching or research

assistantships is contingent upon satisfactory performance in course work, timely completion of examinations, including the written and oral Ph.D. comprehensive examinations, and need and availability of such support. Students on probation are offered support only under exceptional circumstances. The period for which a Ph.D. candidate may receive financial support through the Department of Physics and Astronomy does not normally exceed six years.

**Program of Study.** In order to accommodate the needs for training in preparation for the wide variety of occupations of professional physicists and astrophysicists, in areas ranging from academic faculty to industrial research to administrative positions, doctoral degree programs are offered in physics or applied physics. Within the physics program a wide range of options are offered, as stated below. The goal is to provide, through course work and independent study, competence at advanced levels in fundamental, applied and interdisciplinary branches of physics and astronomy, and demonstrated ability in independent research.

Students enrolled in the Ph.D. program may obtain an "M.S. degree in passing" by satisfactorily filing and completing an M.S. Program of Study, obtaining a GPA of at least 3.00 in a set of core courses which total 24 semester hours, and passing a written comprehensive examination. The core courses shall be those designated as appropriate for the particular emphasis chosen for the student's doctoral program. Graduate core courses satisfactorily completed at other institutions may be waived upon petition by the Graduate Program Committee. Up to nine semester hours of classroom-based courses may be substituted for core courses that are waived by the Graduate Program Committee.

Each student's progress is overseen by a supervisory committee appointed for the student usually during the first year of study. This committee also approves the student's program of study.

The student's individual program includes courses selected, with the approval of the supervisory committee, to make up a coherent program for the achievement of these goals. Students may pursue a wide range of options, including emphasis on one of the following: astronomy and astrophysics, biophysics, condensed matter and materials physics, physics education, or subatomic physics. The program may be directed toward either theoretical or experimental aspects, and frequently includes courses in cognate fields, particularly mathematics, depending on the student's selected field.

*Applied Physics.* With advising from the supervisory committee, a program of study is selected with a major portion in physics and a minor portion (nine semester hours or more to be passed with at least a "B" average) in another area. The supervisory committee should include appropriate representation from the minor area.

*Astronomy and Astrophysics.* The following six AST 598 graduate courses are required for all students enrolled in the emphasis in astronomy and astrophysics.

- AST 598 ST: Astronomical Data Taking and Data Reduction
- AST 598 ST: Cosmology and High-Energy Astrophysics
- AST 598 ST: Extragalactic Astronomy
- AST 598 ST: Galactic Structure
- AST 598 ST: Interstellar Medium and Gaseous Astrophysics
- AST 598 ST: Stellar Interiors and Stellar Evolution

**Course Requirements.** The following basic core of courses or their equivalents is required of all students:

PHY 521 Classical Mechanics.....	3
PHY 531 Advanced Electricity and Magnetism.....	3
PHY 532 Electrodynamics.....	3
PHY 541 Statistical Physics.....	3
PHY 571 Quantum Physics .....	3
PHY 576 Quantum Theory .....	3
or PHY 577 Quantum Theory (3)	
Total .....	18

Additional course work is selected according to emphasis, with the advice and approval of the supervisory committee. Students should ensure that they have sufficient mathematical experience, and if in any doubt, should take PHY 501 Methods of Theoretical Physics.

**Foreign Language Requirements.** None.

**Comprehensive Examinations.** The following examinations are required of all students intending to earn the Ph.D. degree.

**Master of Science Degree in Passing.** Students enrolled in the Ph.D. degree may be awarded an M.S. degree in passing.

**Written Comprehensive Examination**

The subject matter of this examination is classical and quantum mechanics, statistical mechanics, and electricity and magnetism, as represented by the courses PHY 521, 531, 532, 541 and 571 or 576. The examination is given in two four-hour sessions on separate days, but there is no division of subject matter for the separate sessions.

The written comprehensive examination is normally given twice yearly, approximately during registration weeks of the fall and spring semesters. Ph.D. candidates must attempt the examination before the beginning of their third semester as full-time students in the physics graduate program and must pass the examination before the beginning of the fourth semester.

Additional written examinations may be set to examine areas of emphasis. Any further written examinations will be given at least once yearly and must be passed by the beginning of the sixth semester.

**Oral Comprehensive Examination**

Ph.D. candidates are required to pass the oral comprehensive examination by the end of their sixth semester as full-time students in the physics graduate program. The examination is administered and graded by the student's supervisory committee. It tests the student's general knowledge of one of the following four broad areas of current activity in physics:

1. astronomy and astrophysics,
2. atomic and molecular physics,

## GRADUATE PROGRAMS AND COURSES

3. nuclear and particle physics, and
4. condensed matter and materials physics.

The area tested is to be chosen by the student at the time of scheduling of the examination. The student may request to be examined on specific subjects in addition to one of the areas. A proposal for the dissertation topic may be included in the material covered by the examination, subject to prior agreement between the student and the supervisory committee.

**Dissertation Requirements.** A dissertation representing an original contribution to the field, as a result of independent work suitable for publication in a refereed physics or astronomy journal, is required.

**Final Examinations.** A final oral examination that covers, but is not necessarily limited to, the subject of the dissertation is required.

### RESEARCH ACTIVITY

Faculty in the Department of Physics and Astronomy perform frontier research that spans the largest and smallest scales—from the galaxies of the cosmos to the substructure of subatomic particles. Topics include investigations in areas such as astrophysics, biophysics, condensed matter physics, surface physics and materials science, and subatomic physics. Faculty and students regularly conduct experiments using state-of-the-art instruments such as electron microscopes, lasers, computers, space-borne and ground-based observatories, and detector facilities at international accelerator laboratories. This experimental work is completed by theoretical investigations associated with the phenomena explored by these experiments as well as other cutting-edge topics. A major effort in physics education research is influential both locally and nationally. For more details, visit the department's Web site at [phy.asu.edu](http://phy.asu.edu).

### ASTRONOMY (AST)

#### AST 421 Astrophysics I. (3)

*fall*

Selected astrophysical topics, including: stellar evolution, star formation, interstellar medium, galactic structure, extragalactic astronomy, high-energy astrophysics, and cosmology. Prerequisites: AST 321, 322; PHY 311, 314.

#### AST 422 Astrophysics II. (3)

*spring*

Same range of astrophysical topics as for AST 421 but different specific topics are emphasized in a given year. Prerequisites: AST 321, 322; PHY 311, 314.

#### AST 598 Special Topics. (1–4)

*selected semesters*

Topics may include the following:

- Astronomical Data Taking and Data Reduction
- Cosmology and High-Energy Astrophysics
- Extragalactic Astronomy
- Galactic Structure
- Interstellar Medium and Gaseous Astrophysics
- Stellar Interiors and Stellar Evolution

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

### PHYSICAL SCIENCES (PHS)

#### PHS 505 Energy and the Environment. (3)

*summer*

Current problems in energy resources, production, consumption, and conservation. Studio. Prerequisite: instructor approval.

#### PHS 510 Inquiry Physical Science I. (3)

*summer*

Inquiry approach to physical science, standards-based, intended for elementary school teachers. Topics selected: kinematics, dynamics, electricity, magnetism, light, astronomy. Studio. Prerequisite: instructor approval.

#### PHS 520 Inquiry Physical Science II. (3)

*summer*

Inquiry approach to physics and astronomy, standards-based, intended for middle school teachers. Emphasizes technology and modeling. Studio. Prerequisite: instructor approval.

#### PHS 530 Methods of Physics Teaching I. (3)

*summer*

Inquiry approach to high school physics teaching. Studio. Prerequisite: instructor approval.

#### PHS 531 Methods of Physics Teaching II. (3)

*summer*

Extension of modeling techniques introduced in PHY 580. Studio. Prerequisite: PHS 530 or instructor approval.

#### PHS 534 Methods of Teaching Physical Science I, II, III. (3)

*summer*

Design of curriculum and conduct of instruction for physical science courses. Studio. Prerequisite: instructor approval.

#### PHS 540 Integrated Physics and Chemistry. (3)

*summer*

Collaborative inquiry methods for teaching and coordinating physics and chemistry. Studio. Prerequisite: CHM 480 or PHS 530 or PHY 480 or instructor approval.

#### PHS 542 Integrated Mathematics and Physics. (3)

*summer*

Mathematical models and modeling as an integrating theme for secondary mathematics and physics. Studio. Prerequisite: instructor approval.

#### PHS 550 Physics and Astronomy. (3)

*summer*

Astronomy curricula and projects for secondary school, with emphasis on the role of physics in astronomy. Studio. Prerequisite: instructor approval.

#### PHS 556 Astrophysics. (3)

*summer*

Structure and evolution of stars, galaxies, and the universe. For secondary school teachers. Studio. Prerequisite: instructor approval.

#### PHS 560 Matter and Light. (3)

*summer*

Interactions of light with matter. Lasers and spectroscopy. Studio. Prerequisite: instructor approval.

#### PHS 564 Light and Electron Optics. (3)

*summer*

Principles and practice of electron-optical instruments. Studio. Prerequisite: instructor approval.

#### PHS 570 Spacetime Physics. (3)

*summer*

Special and general theories of relativity with implications for space and time travel. Studio. Prerequisite: instructor approval.

#### PHS 581 Structure of Matter and Its Properties. (3)

*summer*

Models of matter and its properties. Studio. Prerequisite: instructor approval.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

**PHYSICS (PHY)****PHY 412 Classical Particles, Fields, and Matter III. (3)***fall*

Electromagnetic fields of moving charges, Maxwell's equations, harmonic phenomena, oscillations, waves, electromagnetic radiation, covariant electromagnetism, introduction to general relativity. Prerequisites: PHY 311, 333. Corequisite: PHY 416 or instructor approval.

**PHY 416 Quantum Physics III. (3)***fall*

Introduces the quantum theory of atoms, molecules, solids and nuclei, Dirac's equation. Prerequisites: PHY 311, 315. Corequisite: PHY 412 or instructor approval.

**PHY 420 Research Paper. (1)***fall and spring*

Scientific report writing. Culminates in a paper based on library or laboratory research or both. Taken in conjunction with other courses as approved. Conference. Prerequisite: instructor approval.

**PHY 441 Statistical and Thermal Physics I. (3)***fall*

Statistical and experimental basis of heat, temperature, and entropy. Mechanical and statistical basis of the laws of thermodynamics. Applications of macroscopic thermodynamics. Phase equilibrium. Prerequisites: PHY 311, 315.

**PHY 442 Statistical and Thermal Physics II. (3)***spring*

Principles and applications of statistical mechanics. Quantum statistics of ideal gases and simple solids. Equilibrium of phases and chemical species. Transport theory. Irreversible processes and fluctuation. Prerequisite: PHY 441.

**PHY 452 Physical Optics. (3)***fall*

Principles of reflection, refraction, diffraction. Additional topics from contemporary optics may include Fourier transform spectroscopy, linear systems theory, holography. 2 hours lecture, 2 hours lab. Prerequisites: PHY 302, 311, 315. Corequisite: PHY 412.

**PHY 462 Subatomic Physics. (3)***spring*

Nuclear properties, models, decays and reactions; fundamental forces, field theories, symmetry principles; hadrons, quarks, and leptons; the Standard Model. Prerequisites: PHY 311, 315.

**PHY 465 Advanced Laboratory II. (2)***fall and spring*

Continuation of PHY 334. Students are encouraged to substitute laboratory research project in consultation with faculty sponsor. Prerequisite: PHY 334.

**PHY 466 Advanced Laboratory III. (1-3)***fall and spring*

Continuation of PHY 465. Prerequisite: PHY 465.

**PHY 480 Methods of Teaching Physics. (3)***spring*

Evaluation of various approaches to the teaching of high school physics. Preparation of demonstrations and experiments. Organization of a laboratory. Designed for secondary school physics teachers. Prerequisite: instructor approval.

**PHY 481 Solid-State Physics. (3)***spring*

Structure, elastic properties, and dynamics of crystals; electron motions in crystals under applied fields. Prerequisites: PHY 311, 315.

**PHY 501 Methods of Theoretical Physics. (3)***fall and spring*

Provides mathematical foundations for graduate students in basic and applied physics. Complex variables, vector spaces, operators, matrices, ordinary differential equations, integral equations and transforms, and special functions. May include additional topics.

**PHY 502 Methods of Theoretical Physics. (3)***fall and spring*

Continuation of PHY 501. Prerequisite: PHY 501.

**PHY 521 Classical Mechanics. (3)***fall*

Variational principles, Lagrange's and Hamilton's equations, rigid body motion, canonical transformations, Hamilton-Jacobi theory.



Leslie Landrum, an academic professional in the Department of Plant Biology, shows plant specimens to boosters of graduate education at the ASU herbarium.

Dennis Durband photo

**PHY 523 Relativity. (3)***selected semesters*

Special and general theories of relativity. Prerequisite: PHY 532 or instructor approval.

**PHY 531 Advanced Electricity and Magnetism. (3)***fall*

Electrostatics and magnetostatics; potential theory and theory of constitutive relations; Maxwell's equations; the wave equation, plane electromagnetic waves, cavities, and wave guides.

**PHY 532 Electrodynamics. (3)***spring*

Special theory of relativity, covariant formulation of electromagnetic interactions; inhomogeneous wave equations, Lienard-Wiechert potentials, and radiation fields; interactions of charged particles and electromagnetic waves, scattering, dispersion. Prerequisites: both PHY 412 and 531 or only instructor approval.

**PHY 541 Statistical Physics. (3)***fall*

Probability theory and principles of statistical inference; evaluating experimental data; foundations of statistical mechanics; general laws of thermodynamics from microscopic theories; calculation of specific properties of bulk matter.

**PHY 551 X-Ray and Electron Diffraction. (3)***spring*

Fresnel and Fraunhofer diffraction in integral formulation; diffraction of x rays and neutrons by crystal lattices; structures of solids, including crystal structure analysis; theory and techniques of electron microscopy/diffraction of crystalline/noncrystalline specimens. Prerequisite: PHY 481 or instructor approval.

**PHY 561 Nuclear Physics. (3)***fall and spring*

Properties of nuclei, conservation laws, internucleon forces, nuclear structure models, reactions and decays, quark model with applications to nuclei. Prerequisite: PHY 576 or instructor approval.

**PHY 562 Nuclear Physics. (3)***fall and spring*

Continuation of PHY 561. Prerequisite: PHY 561 or instructor approval.

## GRADUATE PROGRAMS AND COURSES

### PHY 567 Relativistic Quantum Mechanics and Field Theory. (3)

*spring*

Relativistic quantum mechanics and introduction to the quantum field theory of scalar, spinor, and electromagnetic fields. QED through renormalization theory. Prerequisite: PHY 577.

### PHY 568 Particle Physics Phenomenology. (3)

*spring*

Hadron physics, internal symmetry groups, weak interactions, lepton and quark phenomenology. Prerequisite: PHY 577.

### PHY 569 The Standard Model and Beyond. (3)

*fall*

Introduces and applies the standard model of strong and electroweak interactions. Special topics include recent developments. Prerequisites: PHY 567, 568.

### PHY 571 Quantum Physics. (3)

*spring*

Reviews modern physics, chemistry, math. Differential equation, operator, matrix formulations. Free particle, bound-state problems. Examples across physics and astronomy. Prerequisites: a combination of modern physics and linear and complex algebra and differential equations or only instructor approval.

### PHY 576 Quantum Theory. (3)

*fall and spring*

Abstract approach to quantum mechanics in Hilbert space; observables and their corresponding operators, eigenstates, and eigenvalues; quantum dynamics; approximation methods; systems of identical particles; angular momentum and group representation theory; collision processes; relativistic quantum theory. Prerequisite: PHY 521.

### PHY 577 Quantum Theory. (3)

*fall and spring*

Continuation of PHY 576. Prerequisite: PHY 576.

### PHY 580 Practicum. (1–12)

*selected semesters*

### PHY 581 Solid-State Physics. (3)

*fall*

Quantum theory of solids, including phonons, lattice-specific heats, band-structure models, Fermi surfaces, thermal expansion, plasmons, electron-phonon interactions, and scattering by lattice defects. Pre- or corequisite: PHY 576.

### PHY 582 Solid-State Physics. (3)

*spring*

Elements of transport theory, thermal conduction, electronic conduction in metals, mobility in semiconductors, Hall effect, magnetoresistance, and selected topics of current research. Prerequisite: PHY 581.

### PHY 587 Quantum Optics. (3)

*fall and spring*

Quantization of the electromagnetic field. Quantum theory of coherence, photon counting, photon states, lasers, density operators, and atomic Raman scattering. Prerequisite: PHY 576.

### PHY 588 Quantum Optics. (3)

*fall and spring*

Continuation of PHY 587. Prerequisite: PHY 587.

### PHY 592 Research. (1–12)

*selected semesters*

### PHY 598 Special Topics. (1–4)

*fall and spring*

Topics may include the following:

- Quantum Mechanics. (3)  
*spring*
- Quantum Physics. (3)  
*spring*

### PHY 599 Thesis. (1–12)

*selected semesters*

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

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## Plant Biology

### Master's and Doctoral Programs

[lifesciences.asu.edu/plantbiology](http://lifesciences.asu.edu/plantbiology)

480/965-3414

LSE 218

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### J. Kenneth Hooper, Chair

**Professors:** Arntzen, Backhaus, Frasch, Hooper, Klopatek, Nash, Sommerfeld, Trelease, Vermaas, Webber

**Associate Professors:** Briggs, Clark, Day, Martin, Pigg, Ramakrishna, Roberson, Stromberg, Stutz, Szarek, Towill, Wu

**Assistant Professors:** Rhoads, Wojciechowski

**Academic Professionals:** Bingham, Landrum, Lobrutto, Sharp

**Research Assistant Professors:** Gries, Hu, Joshi, Mor, Walmsley

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The faculty in the Department of Plant Biology offer programs leading to the M.S. and Ph.D. degrees in Plant Biology. Among seven different research activity areas, two academic concentrations are available: ecology and photosynthesis.

Select faculty collaborate in the interdisciplinary program for the M.S. and Ph.D. degrees in Molecular and Cellular Biology (see "Molecular and Cellular Biology," page 270).

The faculty participate in the programs leading to the Master of Natural Science degree (see "Natural Science," page 279) when the primary or secondary area of concentration is in plant biology. Students interested in pursuing the M.N.S. degree through an interdisciplinary program emphasizing any of these areas should contact the Department of Plant Biology for additional information.

Applicants for these degree programs must submit scores on the Graduate Record Examination (GRE) (aptitude). GRE scores in the advanced subject area are recommended.

The graduate programs are designed to prepare students for careers in research, teaching, industry, or governmental agencies.

### MASTER OF SCIENCE

**Prerequisites.** Completion of the requirements for an undergraduate major in the plant sciences, biology, or related discipline, and an adequate background in related courses in chemistry, mathematical, and physical sciences.

**Program of Study.** A minimum of 30 semester hours of graduate credit is required. The program must include at least three semester hours of research, three semester hours of thesis, one semester of the core course PLB 502 Perspectives in Plant Biology and one hour of participatory seminar

(PLB 591). The program is planned by the student in consultation with the supervisory committee.

**Foreign Language Requirements.** None.

**Comprehensive Examinations.** Not required.

**Thesis Requirements.** A thesis is required.

**Final Examinations.** A final research seminar and an oral examination covering the thesis and related subject matter are required.

## DOCTOR OF PHILOSOPHY

See “Doctor of Philosophy,” page 96, for general requirements.

**Program of Study.** A minimum of 84 semester hours of graduate credit is required. The program must include at least 24 hours of research and dissertation credit and at least 30 hours of formal graduate course work. One semester of the core course PLB 502 Perspectives in Plant Biology and two hours of participatory seminar (PLB 591) are included in the required course work. Courses numbered 590 or 790 (Reading and Conference) are not considered formal courses. The program is planned by the student in consultation with a program committee that also administers and evaluates the comprehensive examinations.

**Foreign Language Requirements.** Completion at the undergraduate level of a one-year course with a grade of “C” or higher is required.

The supervisory committee may require the student to complete additional study.

**Comprehensive Examinations.** Written and oral comprehensive examinations administered and evaluated by the student’s program committee are required.

**Dissertation Requirements.** A dissertation based on original work of high quality, demonstrating proficiency in the student’s area of interest, is required. (See “Doctoral Degrees,” page 95.)

**Final Examinations.** A final oral examination in defense of the dissertation is required. It is administered by a dissertation committee consisting of four to five members who previously served on the student’s program committee.

## MOLECULAR BIOSCIENCES/BIO TECHNOLOGY (MBB)

### MBB 445 Techniques in Molecular Biology/Genetics. (2)

*fall and spring*

Molecular genetic principles: plasmid construction, purification, and characterization; PCR; mutageneses; hybridization and sequence analysis; protein quantitation, immunologic detection, and electrophoresis. Cross-listed as MIC 445. Credit is allowed for only MBB 445 or MIC 445. Prerequisites: both BIO 340 and MIC 302 or only instructor approval.

### MBB 446 Techniques in Molecular Biology/Genetics Lab. (2)

*fall and spring*

Molecular genetic techniques; plasmid construction, purification, and characterization; PCR; mutageneses; hybridization and sequence analysis; protein quantitation; immunologic detection and electrophoresis. Cross-listed as MIC 446. Credit is allowed for only MBB 446 or MIC 446. Pre- or corequisite: MBB 445 or MIC 445.

### MBB 484 Internship. (3)

*selected semesters*

### MBB 490 Capstone: Issues in Biotechnology. (2)

*fall and spring*

Integrates science and humanities within problem-solving exercises dealing with intellectual property, ethics, regulatory issues, business practices, and commercialization. Prerequisite: Molecular Biosciences/Biotechnology major or instructor approval.

### MBB 499 Individualized Instruction. (3)

*selected semesters*

## PLANT BIOLOGY (PLB)

### PLB 400 Lichenology. (3)

*spring in odd years*

Chemistry, ecology, physiology, and taxonomy of lichens. 2 hours lecture, 3 hours lab. Prerequisites: preferably both PLB 200 and 201 or only BIO 187 (or its equivalent).

### PLB 402 Mycology. (3)

*spring*

Fungal morphology and systematics with an introduction to fungal cell biology, ecology, economic significance, and growth and development. 2 hours lecture, 3 hours lab. Prerequisites: preferably both PLB 200 and 201 or only BIO 187 (or its equivalent) or only MIC 206.

### PLB 404 Phycology. (4)

*spring*

Algae (both fresh water and marine forms), emphasizing field collection and identification of local representatives. Morphological, ecological, and economic aspects of the algae. 3 hours lecture, 3 hours lab. Fee. Prerequisites: preferably both PLB 200 and 201 or only BIO 187 (or its equivalent).

### PLB 407 Plant Fossils and Evolution. (4)

*spring in odd years*

Broad survey of plant life of the past, including the structure of plant fossils, their geologic ranges, geographic distribution, and paleoenvironment. 3 hours lecture, 3 hours lab or field trip. Prerequisites: preferably both PLB 200 and 201 or only BIO 187 (or its equivalent).

### PLB 410 Angiosperm Taxonomy. (3)

*spring*

Principles underlying angiosperm phylogeny. 2 hours lecture, 3 hours lab. Prerequisite: PLB 310 or instructor approval.

### PLB 411 Trees and Shrubs of Arizona. (3)

*fall*

Identification of woody plants from desert, chaparral, and forest habitats in Arizona. 1 hour lecture, 3 hours lab, field trips. Prerequisites: preferably both PLB 200 and 201 or only BIO 187 (or its equivalent) or only instructor approval.

### PLB 414 Plant Pathology. (3)

*spring*

Identification and control of biotic and abiotic factors that cause common disease problems to plants. Prerequisites: preferably both PLB 200 and 201 or only BIO 187 (or its equivalent) or only instructor approval.

### PLB 502 Perspectives in Plant Biology. (3)

*fall*

Introduces major areas of research within the department with the goal of broadening knowledge to enable multidisciplinary research and communication. Prerequisite: instructor approval.

### PLB 583 OTS: Fieldwork in Tropical Biology. (6–8)

*spring and summer*

Intensive field-orientated classes with Organization for Tropical Studies (OTS) in Costa Rica with emphasis on research in ecology and systematics. Lecture, lab, fieldwork. Cross-listed as BIO 583. Credit is allowed for only BIO 583 or PLB 583. Prerequisites: graduate standing; a course in basic ecology.

### PLB 591 Seminar. (1)

*fall and spring*

## Environmental Science and Ecology

### PLB 420 Plant Ecology: Organisms and Populations. (3)

*spring in odd years*

Factors and controls on the physiological ecology and organization of plants and plant populations using empirical and theoretical approaches. 2 hours lecture, 3 hours lab. Fee. Prerequisite: BIO 320 or PLB 322 (or its equivalent).



## GRADUATE PROGRAMS AND COURSES

### **PLB 421 Plant Ecology: Communities and Ecosystems. (3)**

*spring in even years*

Plant community organization, field sampling techniques, and the structure and function of terrestrial ecosystems emphasizing the role of vegetation. 2 hours lecture, 3 hours lab. Fee. Prerequisite: BIO 320 or PLB 322 (or its equivalent).

### **PLB 422 Plant Geography. (3)**

*selected semesters*

Plant communities of the world and their interpretation, emphasizing North American plant associations. Cross-listed as GPH 422. Credit is allowed for only GPH 422 or PLB 422. Prerequisites: preferably both PLB 200 and 201 or only BIO 187 or only GPH 111.

### **PLB 430 Statistical Analyses in Environmental Science. (3)**

*spring*

ANOVAS, 1-way classification of factorial and partially hierarchic designs; introductory multivariate statistics. Prerequisite: MAT 210 (or its equivalent).

### **PLB 432 Computer Applications in Biology. (3)**

*fall*

Computer analysis techniques in biology emphasizing data entry, management and analysis, and graphic portrayal. Employs mainframe and microcomputers. 2 hours lecture, 3 hours lab. Cross-listed as BIO 406. Credit is allowed for only BIO 406 or PLB 432. Prerequisites: both BIO 187 and MAT 117 (or 210) or only instructor approval.

### **PLB 434 Landscape Ecological Analysis and Modeling. (3)**

*spring in odd years*

Technical methods of landscape ecological analyses. Includes mathematical and statistical examination and modeling of landscape ecological patterns and processes. Prerequisites: both BIO 320 and 406 or only PLB 432 (or its equivalent).

### **PLB 520 Plant Structural Adaptation. (1–3)**

*selected semesters*

Adaptive traits of leaf size/unique growth form on energy transfer efficiency; stomatal architecture and water-use efficiency; applications of stable isotopes. Prerequisite: BIO 320 or PLB 306 (or 308 or its equivalent).

### **PLB 522 Plant Photosynthetic Adaptation. (1–3)**

*selected semesters*

Evolution and ecology of C<sub>4</sub> and CAM; adaptive traits improving competitive ability in natural environments; comparative physiology of desert plants. Prerequisite: PLB 308 or instructor approval.

### **PLB 524 Methods in Environmental Plant Physiology. (3)**

*spring in odd years*

Techniques to measure and quantify microclimate and mass transfer. Supporting principles. 2 hours lecture, 3 hours lab. Prerequisite: BIO 320 or PLB 308.

## **Plant Biochemistry and Molecular Biology**

### **PLB 440 Photobiology. (3)**

*selected semesters*

Principles underlying the effects of light on growth, development, and behavior of plants, animals, and microorganisms. Cross-listed as BIO 464. Credit is allowed for only BIO 464 or PLB 440. Prerequisites: CHM 231 (or 331); 12 hours in life sciences.

### **PLB 444 Plant Growth and Development. (3)**

*spring*

Molecular basis of development, role of signal transduction pathways/gene regulation in control of organ formation, pollination, germination, and growth. Prerequisite: BIO 353.

### **PLB 530 Introduction to Structural and Molecular Biology. (4)**

*spring*

Structure and function of cells, proteins, membranes, and the genome; gene expression and biogenesis of structures; application of computer imaging. Cross-listed as CBS 530. Credit is allowed for only CBS 530 or PLB 530. Prerequisites: one year of biology; one semester of organic chemistry.

### **PLB 540 Plant Biochemistry. (3)**

*selected semesters*

Structure/function relationships of molecules, emphasizing processes unique to plants: carbon fixation, synthesis of storage products, pigments, and secondary metabolites. Prerequisites: both BCH 361 and PLB 308 or only instructor approval.

### **PLB 550 Plant Molecular Biology. (2)**

*spring in odd years*

Biochemistry and molecular biology of plant organelles, including protein targeting, plant viruses, and molecular designs for plant improvements. Prerequisite: instructor approval.

### **PLB 552 Plant Genetic Engineering. (3)**

*spring*

Plant transformation utilization of transgenic plants, transient gene expression assays, and applications of plant genetic engineering. Prerequisite: instructor approval.

### **PLB 553 Plant Genetic Engineering Laboratory. (2)**

*spring*

Plant transformation, utilization of transgenic plants, transient gene expression assays, and applications of plant genetic engineering. 6 hours lab. Prerequisite: instructor approval.

### **PLB 554 Plant Biotechnology. (3)**

*selected semesters*

Aseptic, clonal propagation of plants and in vitro culture of cells, organs, and tissues. 2 hours lecture, 3 hours lab. Prerequisite: PLB 308 or 370.

### **PLB 558 Molecular Mechanisms of Photosynthesis. (3)**

*spring*

Structure and function of photosynthetic complexes; mechanism of energy conversion in plants, bacteria, and model systems. Cross-listed as BCH 568. Credit is allowed for only BCH 568 or PLB 558. Prerequisite: instructor approval.

### **PLB 576 Functional Genomics. (2)**

*spring*

Functional relevance of genomic sequences; DNA arrays, proteomics, analysis of genomic information for metabolic physiology of organisms. Cross-listed as MCB 576. Credit is allowed for only MCB 576 or PLB 576. Prerequisite: MAT 351.

## **Urban Horticulture**

### **PLB 472 Greenhouse/Nursery Management. (3)**

*spring in even years*

Greenhouse structures, environment, and nursery operation. Includes irrigation, nutrition, and other principles relative to container-grown species. Fee. Prerequisites: ERS 130 (or 225 or 226); PLB 260.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

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## **Political Science**

### **Master's and Doctoral Programs**

[www.asu.edu/clas/polisci](http://www.asu.edu/clas/polisci)

480/965-7667

SS 412

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### **Robert L. Youngblood, Chair**

**Professors:** Ball, Berman, Chaudhuri, Dagger, Jones, Kahn, Kenney, McDonough, McGowan, Simon, Walker, Youngblood

**Associate Professors:** Ashley, Crittenden, Dantico, Doty, Herrera, Keating, Mitchell, Simhony, Spruyt, Warner

**Assistant Professors:** Chin, C. Elman, M. Elman, Goren, Krutz

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The faculty in the Department of Political Science offer graduate programs leading to the M.A. and Ph.D. degrees in Political Science. Concentrations are available in American

politics, comparative politics, international relations, and political theory.

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

## MASTER OF ARTS

See “Master’s Degrees,” page 93, for general requirements.

**Admission.** The M.A. degree provides advanced education for those students preparing for teaching, research, or applied careers in political science. It may be taken as a terminal program or as a step toward eventual fulfillment of the requirements for the Ph.D. Students may apply directly to the doctoral program or master’s program.

In addition to the materials sent to the Graduate College, the following items should be submitted to the director of graduate studies of the Department of Political Science by April 15 in order to ensure recommendations for admission to the M.A. program beginning the following fall:

1. scores from the verbal, quantitative, and analytical sections of the Graduate Record Examination (GRE);
2. three letters of recommendation from persons who can evaluate the applicant’s academic performance and potential;
3. a career overview statement which describes the applicant’s educational objectives; and
4. a writing sample that best represents the applicant’s thinking and writing skills.

Applicants for financial aid should submit these items and complete the application form for graduate assistantships by February 15. The department also has an early admission deadline in late November. Candidates who have submitted a complete application by that date will be notified of their status by the end of the calendar year.

Undergraduate course work in political science is not a prerequisite for admission.

It is assumed, however, that M.A. students have a basic understanding of elementary statistics and the undergraduate content of the political science fields of concentration that they wish to study. Students without such a background should allow sufficient time to acquire it.

**Program of Study.** A minimum of 30 semester hours is required for the Master of Arts degree. All candidates must take POS 503 and the core course in the student’s major and minor fields. Additional hours must be taken in graduate-level courses and seminars. Each student is expected to take seminars each semester in his/her major field, minor field, and an elective until course work is completed. If the thesis option is followed, the program must include a combination of at least six semester hours of research (POS 592) and thesis (POS 599) credit. A maximum of six semester hours in approved courses taken outside the department or six hours of reading and conference (POS 590) courses may count towards the 30-hour requirement.

**Foreign Language Requirement.** None.

**Thesis Option Requirements.** M.A. students seeking admission to the Ph.D. program are expected to complete the thesis early in their fourth semester. A copy of the *Format Manual* is available in the Graduate College. A careful review of this document well in advance of preparation for the final copy of the thesis is recommended. An oral examination in defense of the thesis is required.

**Non-Thesis Option Requirements.** The program of study must include 27-hours of approved course work and at least one three-hour reading and conference course (POS 590) in the fourth semester to enhance the student’s research capabilities. A research paper must be defended by the end of the third semester before a faculty committee appointed by the director of Graduate Studies.

## DOCTOR OF PHILOSOPHY

See “Doctor of Philosophy,” page 96, for general requirements.

**Admission.** In addition to meeting Graduate College requirements, an applicant for the Ph.D. program must take the verbal, quantitative, and analytical sections of the GRE; supply a career overview statement that describes the applicant’s educational objectives; submit three letters of recommendation from persons who can evaluate the applicant’s undergraduate and graduate work; and provide a sample of writing. These items should be submitted to the director of graduate studies of the Department of Political Science by February 15. Applicants for financial aid should also complete and submit the application form for graduate assistantships by February 15. The department also has an early admission deadline in late November. Candidates who have submitted a complete application by that date will be notified of their status by the end of the calendar year.

It is assumed that Ph.D. students have a basic understanding of elementary statistics and the content of the areas of concentration that they wish to study. Students without such a background should allow sufficient time to acquire it.

**Program of Study.** A minimum of 60 semester hours of graduate courses beyond the baccalaureate degree and approved by the student’s supervisory committee shall constitute the formal course preparation, followed by a minimum of 24 semester hours of research and dissertation work. The supervisory committee has three members, including the committee chair from the student’s major field, and two members from a minor field. As part of the 60 semester hours, the student must take POS 503 and 603. A maximum of 12 semester hours of approved course work outside the department and 12 semester hours of approved reading and conference courses (POS 590 and 790) may count toward the 60 semester hours. Grades of “A,” “B,” or “Y,” must be obtained in all course work counted for the Ph.D. degree.

**Master’s in Passing.** For students without an M.A. who are admitted directly into the Ph.D. program, the department offers a Master’s in Passing. Students opting for the Master’s in Passing must, in the third semester of residence, pass an oral examination of their work. The examination is conducted by a committee composed of members of the

## GRADUATE PROGRAMS AND COURSES

Graduate Committee who represent each student's primary and secondary subfields. Students who pass the oral examination and have completed 30 semester hours of course work toward the Ph.D. are then awarded the M.A.

**Research Skills/Foreign Language Requirements.** All Ph.D. students must show proficiency in research and methodological skills. This requirement may be met by showing proficiency in one or more of the following areas: foreign language, quantitative, or qualitative methods. Supervisory committees determine which among those research tools are appropriate for students in their fields of study.

**Comprehensive Examination.** The student is required to take three examinations from the fields and subfields of American politics, international relations, comparative politics, and political theory. In the major field, the student takes a written general examination. Additionally, the student takes a written field or subfield examination in one of the remaining fields of political science. An oral examination over the dissertation proposal follows the written examinations.

**Dissertation Requirements.** The dissertation must be an original contribution to knowledge and demonstrate the student's proficiency as an independent investigator. The dissertation proposal is approved by the chair of the department upon the recommendation of the student's dissertation committee. The department chair also approves the dissertation committee. This committee must have a minimum of three members from the department of political science, including a chair from the student's major field.

**Final Examinations.** A final oral examination is required. This examination is the occasion for the student to defend the dissertation, both as to methods and conclusions, and to demonstrate general competence in the area of concentration.

### RESEARCH ACTIVITY

Political science faculty and the department's curriculum are organized into four areas of concentration. The faculty offer courses and conduct research from a variety of methodological orientations, all with a common thread of theoretically oriented scholarship.

*American Politics.* Faculty emphasize political behavior and use survey research, experimental designs, and content analysis to collect data and conduct statistical analyses of mass voting patterns, campaign strategies, party politics, the role of the media in political communication, agenda setting and policy development in Congress, and elite-mass linkages. Other faculty emphasize public law and policy with a focus primarily at the state and local levels of government.

*International Relations.* One group focuses on foreign policy theory and international security, using event chronologies, institutional differences, archival materials, and public records to guide comparative analyses of foreign policy decision-making by different types of regimes, case studies of leaders and their decision-making strategies, state and nation building, nationalism, and policy analyses of issues in the Asia-Pacific region. Another cluster of faculty emphasize critical theory and the international political economy,

employing archival sources, statistical data, and texts of legal norms and state practices to conduct analyses of global inequalities in wealth and income, the evolution of statecraft, and the impact of hierarchically-ordered gender and race categories in North-South relations.

*Political Theory.* Faculty research interests in the area of political theory cover a range of topics in the history of political thought and contemporary political theory. Historical topics include Rousseau, conceptual history, and positive liberalism of the 19th and 20th centuries. Research in contemporary political theory focuses on such themes as autonomy and freedom, rights and obligations, civic virtues, and the idea of the common good; various issues in democratic theory (with particular attention to education), aspects of political and legal theory regarding corporate personality, conceptions of self in various cultures, analysis of myths in aboriginal societies and politics, social ecology, and peace and nonviolence.

*Comparative Politics.* Faculty in the area of comparative politics investigate a variety of topics in several regions of the globe. Research interests include the political economy of uneven development in Africa, democratization processes within formerly authoritarian regimes in Europe, Latin America, and East Asia, church and state relations in the Philippines, ethnic minority problems in Brazil, problems of federalism in India, and party leadership in France and Italy.

### POLITICAL SCIENCE (POS)

#### POS 501 Methods of Political Science. (3)

*selected semesters*

Problems of method and knowledge in political science, strategies of political inquiry, and issues in philosophy of social science.

#### POS 502 Philosophy of Political Inquiry. (3)

*once a year*

Problems of knowledge and method in political science, with attention to both empirical and evaluative analysis.

#### POS 503 Empirical Political Inquiry. (3)

*once a year*

Research methods and techniques of the discipline, emphasizing empirical foundations and analytic methods employed in subfields. Prerequisites: POS 401 (or its equivalent); instructor approval.

#### POS 530 American Politics. (3)

*once a year*

Examines major debates in the study of American political processes and institutions. Covers parties, media, elections, public opinion, interest groups, and the three branches of government. Seminar.

#### POS 545 Themes in Political Thought. (3)

*selected semesters*

Examines a particular theme or problem in political thought from both a historical and contemporary perspective. May be repeated with approval of the director of graduate studies. Seminar. Prerequisite: instructor approval.

#### POS 550 Comparative Politics. (3)

*once a year*

Surveys major approaches across topical areas such as revolutions, authoritarianism, policy processes, interest groups, and electoral politics. Focus varies with instructor. Seminar.

#### POS 560 International Relations. (3)

*once a year*

Surveys major theoretical approaches and debates in international relations. Seminar.

#### POS 563 Comparative Asian Security Policies. (3)

*selected semesters*

Analyzes domestic and international constraints, belief systems, and economic components in security decisions by major powers and Asian nations. Seminar. Prerequisite: instructor approval.

**POS 590 Reading and Conference. (1–12)**

*selected semesters*

**POS 591 Seminar. (1–12)**

*once a year*

Topics may include the following:

- American Politics. (3)
- Comparative Politics. (3)
- Global Politics. (3)
- Political Theory. (3)

**POS 592 Research. (1–12)**

*selected semesters*

**POS 598 Special Topics. (1–4)**

*once a year*

Topics may include the following:

- American Politics. (3)
- Comparative Politics. (3)
- Global Politics. (3)
- Political Theory. (3)

**POS 599 Thesis. (1–12)**

*selected semesters*

**POS 601 Advanced Experimental Research. (3)**

*selected semesters*

Introduces experimental and quasi-experimental research designs in political research, including laboratory techniques and topics in the analysis of variance. Prerequisite: POS 503 (or its equivalent).

**POS 602 Advanced Survey Research. (3)**

*selected semesters*

Presents design and conduct of political surveys, including sampling, instrument design, scaling, and statistical and graphical analysis of survey data. Prerequisite: POS 503 (or its equivalent).

**POS 603 Polimetrics I. (3)**

*once a year*

Introduces theory and practice of linear regression analysis. Provides skills to read, understand, and evaluate professional literature using regression analysis. Prerequisites: both POS 401 and 503 or only instructor approval.

**POS 604 Polimetrics II. (3)**

*once a year*

Applies quantitative techniques to research topics producing publishable papers through exposure to time-series, logit and probit, and simultaneous equations. Prerequisites: a combination of POS 401 and 503 and 603 or only instructor approval.

**POS 606 Qualitative and Textual Analysis. (3)**

*spring in odd years*

Method and theory for the analysis of qualitative materials, systematic approaches for case studies, content analysis, critical analysis of texts. Discussion, seminar.

**POS 635 State Politics and Public Policy. (3)**

*selected semesters*

Introduces comparative state policy emphasizing policy or performance differences among the states and the reasons for these differences. Seminar. Prerequisites: both POS 530 and 603 or only instructor approval.

**POS 636 Electoral Behavior. (3)**

*selected semesters*

Introduces fundamental concepts of electoral behavior. Emphasizes presidential elections and examines why people vote and how their votes are determined. Seminar. Prerequisites: both POS 530 and 603 or only instructor approval.

**POS 638 Law and Politics. (3)**

*selected semesters*

Emphasizes research into such topics as constitutional law, women and the law, American legal system, judicial process, and judicial selection. Seminar. Prerequisite: instructor approval.

**POS 651 Politics of Change and Development. (3)**

*selected semesters*

Examines contending approaches to national, social, and political change. Seminar. Prerequisite: instructor approval.

**POS 660 The Modern World System. (3)**

*selected semesters*

Theoretically driven, historical analysis of the organization and operation of the international political economy since the 16th century. Seminar. Prerequisite: instructor approval.

**POS 661 The State. (3)**

*selected semesters*

Examines theories of state, state-society relations, and interstate politics emphasizing questions of sovereignty, territoriality, violence, representation, democracy, and change. Seminar. Prerequisite: instructor approval.

**POS 662 International Organization. (3)**

*selected semesters*

History, practical political significance, and future of international institutions, transnational regimes, and other approaches to international organization. Seminar. Prerequisite: instructor approval.

**POS 664 War, Peace, and Conflict Processes. (3)**

*selected semesters*

Systematic analysis of the causes of war, the preconditions for peace, and approaches to the resolution of conflict. Seminar. Prerequisite: instructor approval.

**POS 665 Foreign Policy Theory. (3)**

*selected semesters*

Examines foreign policy theory and methods. Development and critique of research designs analyzing foreign policy processes within and among nations. Seminar. Prerequisite: instructor approval.

**POS 691 Seminar. (1–12)**

*selected semesters*

**POS 790 Reading and Conference. (1–12)**

*selected semesters*

**POS 792 Research. (3)**

*fall and spring*

Projects in various areas of political science. Prerequisite: doctoral student.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 48.

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## Post-Bachelor's Artist Diploma

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See "Post-Bachelor's Artist Diploma," page 276.

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## Post-Master's Nurse Practitioner Certificate

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For information, see "Nursing," page 281, or call the College of Nursing Student Services Office at 480/965-2987.

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## Professional Accountancy Certificate Program

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ASU West offers a postbaccalaureate certificate in Professional Accountancy. For information, see the *ASU West Catalog*, call 602/543-4567, or access [www.west.asu.edu](http://www.west.asu.edu) on the Web.