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## Industrial Engineering

### Master's and Doctoral Programs

[ceaspub.eas.asu.edu/ie](http://ceaspub.eas.asu.edu/ie)

480/965-3185

GWC 502

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Gary L. Hogg, Chair

**Professors:** Cochran, Fowler, Henderson, Hogg, Hubele, Montgomery, Runger, Shunk, Wolfe, Ye

**Associate Professors:** Anderson-Rowland, Mackulak, Moor, Roberts, Villalobos

**Assistant Professors:** Gel, Keha, Kulahci, Wu

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The faculty in the Department of Industrial Engineering offer graduate programs leading to the M.S., the Master of Science in Engineering, and the Ph.D. degrees in Industrial Engineering.

The overall educational objective of graduate study in industrial engineering is to improve each student's ability to understand, analyze, and resolve problems within complex organizations. Industrial engineers must develop qualitative and quantitative abilities to assist management in such diverse organizations as banks, government, hospitals, military, and manufacturing operations.

All students applying for one of the master's or doctoral degree programs must submit scores (verbal, quantitative, analytical) on the Graduate Record Examination, a statement of purpose, and three letters of recommendation. Applicants may have a baccalaureate degree in a major field other than industrial engineering, although engineering, mathematics, or science is recommended. The student's qualifications are reviewed by the faculty.

### MASTER OF SCIENCE

The M.S. is a research degree requiring a thesis and an oral defense. See "Master's Degrees," page 94, for general requirements.

### MASTER OF SCIENCE IN ENGINEERING

The Master of Science in Engineering (M.S.E.) degree is a non-research degree requiring additional course work and a written comprehensive examination. See "Master of Science in Engineering," page 204, for more information.

### DOCTOR OF PHILOSOPHY

The Ph.D. degree in Industrial Engineering is conferred upon evidence of excellence in research that culminates in a dissertation representing a significant contribution to the field of industrial engineering. See "Doctor of Philosophy," page 96, for general requirements.

**Program of Study.** The program of study should be developed early in the second semester of Ph.D. study or upon completion of nine semester hours of courses at ASU. Specific requirements may be obtained from the department.

**Early Evaluation.** In the second regular semester in residence, the student's program of study and academic accomplishment to date serve as a basis for evaluation by the supervisory committee. The results of this evaluation are used to assist the student in improving or modifying the program of study, to encourage the continuance of Ph.D. studies or, if necessary, to discourage the student from continuing in the program.

**Foreign Language Requirements.** None.

**Comprehensive Examinations.** When the Ph.D. student has essentially completed the course work in the approved program of study and submitted a research proposal to the advisory committee, the student is given a written comprehensive examination relating to the research area. The written examination is followed by an oral exam. Upon successful completion of the comprehensive examinations, the student is admitted to candidacy.

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

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

### RESEARCH ACTIVITY

For up-to-date information about research activity, access the department's Web site at [ceaspub.eas.asu.edu/ie](http://ceaspub.eas.asu.edu/ie).

### INDUSTRIAL ENGINEERING (IEE)

#### IEE 505 Information Systems Engineering. (3)

*fall and spring*

Studies information systems application engineering. Topics include information technology, data modeling, data organization, process mapping, application and database engineering, and user interface development. Fee. Prerequisites: CSE 200; graduate standing.

#### IEE 511 Analysis of Decision Processes. (3)

*spring*

Methods of making decisions in complex environments and statistical decision theory; effects of risk, uncertainty, and strategy on engineering and managerial decisions. Prerequisites: ECE 380; graduate standing.

#### IEE 530 Enterprise Modeling. (3)

*spring*

Focuses on social, economic, and technical models of the enterprise with emphasis on the management of technological resources. Includes organization, econometric, financial, and large-scale mathematical models. Prerequisite: graduate standing.

#### IEE 532 Management of Technology. (3)

*fall*

Topics include designing a technical strategy; technological forecasting; interfacing marketing engineering and manufacturing; designing and managing innovation systems; creativity; application of basic management principles to technology management. Prerequisite: IEE 431 or 541.

#### IEE 533 Scheduling and Network Analysis Models. (3)

*spring*

Applies scheduling and sequencing algorithms, deterministic and stochastic network analysis, and flow algorithms. Prerequisites: ECE 380; IEE 376.

**IEE 541 Engineering Administration. (3)**

*fall*

Introduces quantitative and qualitative approaches to management functions, engineering administration, organizational analysis, decision making, and communication. Credit is allowed for only IEE 541 or 431. Prerequisite: graduate standing.

**IEE 543 Computer-Aided Manufacturing and Control. (3)**

*spring*

Computer control in manufacturing, CIM, NC, logic controllers, group technology, process planning and robotics. Credit is allowed for only IEE 543 or 463. Prerequisite: graduate standing.

**IEE 545 Simulating Stochastic Systems. (3)**

*fall and spring*

Analyzes stochastic systems using basic queuing networks and discrete event simulation. Basic network modeling, shared resources, routing, assembly logic. Credit is allowed for only IEE 545 or 475. Prerequisites: CSE 200; IEE 376. Pre- or corequisite: IEE 385.

**IEE 547 Human Factors Engineering. (3)**

*fall and spring*

Study of people at work; designing for human performance effectiveness and productivity. Considerations of human physiological and psychological factors. Credit is allowed for only IEE 547 or 437. Prerequisite: graduate standing.

**IEE 552 Strategic Technological Planning. (3)**

*spring*

Studies concepts of strategy, strategy formulation process, and strategic planning methodologies with emphasis on engineering design and manufacturing strategy, complemented with case studies. Presents and uses an analytical executive planning decision support system throughout course. Prerequisite: graduate standing. Pre- or corequisites: IEE 545, 561, 572, 574.

**IEE 560 Object-Oriented Information Systems. (3)**

*spring*

Applies object-oriented technology and concepts to enterprise information systems. Topics include requirement analysis, object-oriented design and programming, rapid application development, object data management, and development of object-oriented distributed applications. Fee. Prerequisite: IEE 505.

**IEE 561 Production Systems. (3)**

*spring*

Understanding how factories operate, how performance is measured, and how operational changes impact performance metrics. Operational philosophies, increasing production efficiency through quantitative methods. Prerequisites: IEE 376, 385.

**IEE 562 Computer-Aided Manufacturing (CAM) Tools. (3)**

*spring*

Current topics in automation, distributed control, control code generation, control logic validation, CAM integration, CAD/CAM data structures, planning for control systems. Topics vary by semester. Prerequisite: IEE 463 or 543.

**IEE 563 Distributed Information Systems. (3)**

*fall and spring*

Introduces concepts and technologies that form the core of distributed enterprise information systems. Topics include client-server architectures, distributed objects and paradigms, Internet, World Wide Web, distributed information sharing, network programming, and e-commerce and enterprise applications. Fee. Prerequisite: IEE 505.

**IEE 564 Planning for Computer-Integrated Manufacturing. (3)**

*fall*

Theory and use of IDEF methodology in planning for flexible manufacturing, robotics, and real-time control. Simulation concepts applied to computer-integrated manufacturing planning. Prerequisite: graduate standing.

**IEE 565 Computer-Integrated Manufacturing Research. (3)**

*spring*

Determination and evaluation of research areas in computer-integrated manufacturing, including real-time software, manufacturing information systems, flexible and integrated manufacturing systems, robotics, and computer graphics. Prerequisite: IEE 564.

**IEE 566 Simulation in Manufacturing. (3)**

*spring in even years*

Uses simulation in computer-integrated manufacturing with an emphasis on modeling material handling systems. Programming, declarative,

and intelligence-based simulation environments. Prerequisite: IEE 475 or 545.

**IEE 567 Simulation System Analysis. (3)**

*fall*

Simulation modeling of processes involving discrete and continuous system components. Topics include random number generators, output analysis, variance reduction, and statistical issues related to simulation. Prerequisite: IEE 475 or 545.

**IEE 570 Advanced Quality Control. (3)**

*spring*

Process monitoring with control charts (Shewhart, cusum, EWMA), feedback adjustment and engineering process control, process capability, autocorrelation, selected topics from current literature. Prerequisite: IEE 385.

**IEE 571 Quality Management. (3)**

*fall*

Total quality concepts, quality strategies, quality and competitive position, quality costs, vendor relations, the quality manual, and quality in the services. Prerequisite: graduate standing.

**IEE 572 Design of Engineering Experiments. (3)**

*fall and spring*

Analysis of variance and experimental design. Topics include strategy of experimentation, factorials, blocking and confounding, fractional factorials, response surfaces, nested and split-plot designs. Prerequisite: ECE 380.

**IEE 573 Reliability Engineering. (3)**

*spring*

Nature of reliability, time to failure densities, series/parallel/standby systems, complex system reliability, Bayesian reliability, and sequential reliability tests. Prerequisite: ECE 380.

**IEE 574 Applied Deterministic Operations Research Models. (3)**

*fall and spring*

Develops advanced techniques in operations research for the solution of complex industrial systems problems. Goal programming, integer programming, heuristic methods, dynamic and nonlinear programming. Prerequisite: IEE 376 or 385.

**IEE 575 Applied Stochastic Operations Research Models. (3)**

*spring*

Formulate and solve industrial systems problems with stochastic components using analytical techniques. Convolution, continuous-time Markov chains, queues with batching, priorities, balking, open/closed queuing networks. Prerequisites: IEE 376, 385.

**IEE 576 Modeling and Analysis of Semiconductor Manufacturing Operations. (3)**

*fall*

Applies operations research and statistical methods to solve problems that involve semiconductor manufacturing operations. Prerequisites: IEE 376, 385.

**IEE 577 Advanced Information System Operations. (3)**

*fall*

Industrial engineering knowledge and skills for information system operations, including aspects (security, quality of service, user interface, information modeling), problems, and solutions. Prerequisite: IEE 505.

**IEE 578 Regression Analysis. (3)**

*fall*

Regression model building oriented toward engineers and physical scientists. Topics include linear regression, diagnostics, biased and robust fitting, nonlinear regression. Prerequisite: IEE 385.

**IEE 579 Time Series Analysis and Forecasting. (3)**

*fall in odd years*

Forecasting time series by regression-based, exponential smoothing, and ARIMA model techniques; uses digital computer programs to augment the theory. Prerequisite: IEE 385.

**IEE 582 Response Surfaces and Process Optimization. (3)**

*spring*

Classical response surface analysis and designs, including steepest ascent, canonical analysis, and multiple responses. Other topics include process robustness studies, robust design, and mixture experiments. Prerequisite: IEE 572.

## GRADUATE PROGRAMS AND COURSES

### IEE 584 Internship. (3)

*spring*

Work performed in an industrial setting that provides practical experience and adds value to the classroom and research learning process. Practice.

### IEE 593 Applied Project. (1–12)

*selected semesters*

### IEE 594 Conference and Workshop. (1)

*fall and spring*

Orientation to the developing work in the field with an emphasis on what the IE faculty are doing.

### IEE 598 Special Topics. (1–4)

*selected semesters*

Topics may include the following:

- Advanced Topics in Deterministic Operations Research. (3)
- Advanced Topics in Scheduling. (3)
- Data Mining: Analysis of Massive Data Sets. (3)
- Design and Manufacturing. (3)
- Embedded Systems. (3)
- Engineering Approaches to Information Systems Security. (3)
- Enterprise Internet/Intranet. (3)
- Enterprise Modeling/Integration. (3)
- Entrepreneurship for Engineers. (3)
- Introduction to Rapid Prototyping and Mechatronics. (3)
- Manufacturing and Logistics Systems. (3)
- Multicriteria Decision Making. (3)
- Performance-Based Decision Support Systems. (3)
- Six-Sigma Methodology. (3)
- Strategic Technical Management. (3)
- Strategic Issues in Manufacturing. (3)
- Supply Chain Modeling and Analysis. (3)

### IEE 599 Thesis. (1–12)

*selected semesters*

### IEE 672 Advanced Topics in Experimental Design. (3)

*spring in even years*

Multilevel and mixed-level factorials and fractions, design optimality, incomplete blocks, unbalanced designs, random effects and variance components, analysis of covariance. Prerequisite: IEE 572.

### IEE 677 Regression and Generalized Linear Models. (3)

*spring in odd years*

Theory of linear models, including least squares, maximum likelihood, likelihood-based inference. Generalized linear models, including Poisson and logistic regression, generalized estimating equations. Prerequisite: IEE 578.

### IEE 679 Time Series Analysis and Control. (3)

*fall in even years*

Identification, estimation, diagnostic checking techniques for ARIMA models, transfer functions, multiple time series models for feedback and feedforward control schemes. Prerequisite: IEE 579.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see “Omnibus Courses,” page 50.

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## Information Management

### Master’s Program

[wpcarey.asu.edu/is](http://wpcarey.asu.edu/is)

480/965-3252

BA 223

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### Robert St. Louis, Chair

**Professors:** J.R. Boatsman, Christian, Goul, Johnson, Kaplan, Pany, Pei, Reckers, Roy, St. Louis, Schultz, Steinbart, Vinze

**Associate Professors:** Boyd, David, Golen, Gupta, Hwang, Iyer, Keim, Kulkarni, O’Leary, Regier, Whitecotton

**Assistant Professors:** Chen, Comprix, Dowling, Lee, O’Donnell, Petersen, Ravindran, Robinson, Roussinov, Rowe, Santanam, Shao, Weiss

**Senior Lecturers:** Goldman, Maccracken, Shrednick

**Lecturers:** J.L. Boatsman, Geiger, Hayes

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The faculty in the Department of Information Systems, W. P. Carey School of Business, offer a specialized professional program leading to the M.S. degree in Information Management. The faculty also participate in programs leading to the Master of Business Administration (see “Master of Business Administration,” page 138) and Ph.D. degree in Business Administration (see “Doctor of Philosophy,” page 139). For more information, access the department’s Web site at [wpcarey.asu.edu/is](http://wpcarey.asu.edu/is).

### MASTER OF SCIENCE

The program leading to the M.S. degree in Information Management educates working professionals to develop and apply quantitative and computer methods to support business decision making. The program prepares graduates to progress in careers in computer information systems/management, systems development and business consulting.

**Admission.** All applicants are required to submit the supplemental application materials required by the department. Complete application instructions may be obtained from the department’s Web site at [wpcarey.asu.edu/is](http://wpcarey.asu.edu/is).

Applicants must also submit scores from the Graduate Management Admission Test or the Graduate Record Examination. International applicants whose native language is not English must submit scores from the Test of English as a Foreign Language and Test of Spoken English exams.

**Prerequisites.** Applicants must complete the program prerequisites. Refer to the department’s Web site for a current list of required course prerequisites.

**Program of Study.** The program of study consists of a minimum of 30 semester hours and is continually updated. Access the department’s Web site for a list of courses.

**Foreign Language Requirements.** None.

**Thesis Requirements.** None.

**Final Examination.** For the M.S. degree, all students must successfully complete the comprehensive requirement established by the department and the Graduate College. The comprehensive requirement may take the form of a final written examination or may be integrated into the applied project, depending on the program of study.

## RESEARCH ACTIVITY

For current information about research activity, access the department's Web site at [wpcarey.asu.edu/is](http://wpcarey.asu.edu/is).

### COMPUTER INFORMATION SYSTEMS (CIS)

#### **CIS 502 Management Information and Decision Support Systems. (1–4)**

*once a year*

Fundamentals of computer-based management information and decision support systems. Prerequisite: M.B.A. degree program student.

#### **CIS 505 Object-Oriented Modeling and Programming. (1–4)**

*once a year*

Object-oriented modeling of business information systems, abstract data types and object-oriented programming using a visual language. Prerequisite: M.S. in Information Management degree program student or M.A.I.S. degree program student.

#### **CIS 506 Business Database Systems. (1–4)**

*once a year*

Hierarchical, network, relational, and other recent data models for database systems. Processing issues such as concurrency control, query optimization, and distributed processing. Prerequisite: M.S. in Information Management degree program student or M.A.I.S. degree program student.

#### **CIS 512 Intelligent Decision Systems and Knowledge Management. (1–4)**

*once a year*

Definition, description, construction, and evaluation of computer-based decision systems. Prerequisite: M.S. in Information Management degree program student or M.A.I.S. degree program student.

#### **CIS 515 Management Information Systems. (1–4)**

*selected semesters*

Systems theory concepts applied to the collection, retention, and dissemination of information for management decision making. Prerequisite: M.S. in Information Management degree program student or M.A.I.S. degree program student.

#### **CIS 520 Systems Design and Evaluation. (1–4)**

*selected semesters*

Methodologies of systems analysis and design. Issues include project management, interface, organizational requirements, constraints, documentation, implementation, control, and performance evaluation. Prerequisite: M.S. in Information Management degree program student or M.A.I.S. degree program student.

#### **CIS 530 Information Systems Development. (1–4)**

*once a year*

Object-oriented and interprocess communication and control concepts for information systems; applications based on languages such as C++ and platforms such as networked UNIX. Prerequisite: M.S. in Information Management degree program student or M.A.I.S. degree program student.

#### **CIS 535 Distributed and Mixed-Media Information Systems. (1–4)**

*once a year*

Modern communications protocols for wireless and mobile computing, overview of network and distributed database management systems, overview of storage and multimedia delivery issues, and shared virtual reality technologies. Prerequisite: M.S. in Information Management degree program student or M.A.I.S. degree program student.

#### **CIS 591 Seminar on Selected CIS Topics. (1–12)**

*once a year*

Topics may include the following:

- Computer Security
- Computing Architectures
- Data Warehouse and Data Mining
- Electronic Commerce
- Enterprise Modeling

Prerequisite: M.S. in Information Management degree program student or M.A.I.S. degree program student.

#### **CIS 593 Applied Project. (1–12)**

*once a year*

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 50.

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## Institutional Research

### Certificate Program

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For information on the new Graduate Certificate in Institutional Research, call the Division of Educational Leadership and Policy Studies at 480/965-6357.

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## Interdisciplinary Studies

### Master's Program

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ASU West offers a Master of Arts degree in Interdisciplinary Studies. 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.

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## Justice Studies

### Master's Program

[www.asu.edu/copp/justice](http://www.asu.edu/copp/justice)

480/965-7682

WILSN 331

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**Doris Marie Provine, Director, School of Justice Studies**

**Regents' Professor:** Altheide

**Professors:** Cavender, Haynes, Hepburn, Johnson, Jurik, Lauderdale, Provine, Romero, Schneider, Walker, Zatz

**Associate Professors:** Bortner, Lujan, Menjivar, Riding In

**Assistant Professors:** Adelman, Hanson, Kupchik, Lopez, Milun, Monahan

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The faculty in the School of Justice Studies offer a program leading to the M.S. degree in Justice Studies. Information about the interdisciplinary Ph.D. degree in Justice

## GRADUATE PROGRAMS AND COURSES

Studies may be obtained from the graduate coordinator's office. See "Justice Studies," page 249.

### MASTER OF SCIENCE

The study of justice is an interdisciplinary field of scholarship, research, and teaching, embracing those aspects of social and behavioral sciences relevant to an understanding of law, justice, crime, and social deviance. It includes a critical examination of the policies and organizational processes that have evolved for handling attendant problems. The M.S. degree has been designed to prepare students for professional positions in justice-related agencies, for teaching in community colleges, and for further study and research in the justice field.

**Admission.** In addition to meeting Graduate College requirements, applicants must submit Graduate Record Examination (GRE) scores or their Law School Admission Test (LSAT) score; a one- or two-page statement outlining their educational and career goals related to Justice Studies and their areas of interest; and three letters of recommendation, preferably from academic referees. Because of enrollment limits, candidates who meet minimum requirements are not automatically admitted into the program.

**Selection Criteria.** In selecting promising candidates, the admissions committee evaluates past academic performance, scores from the GRE, and potential for success as indicated by recommendations and personal statements.

Applications to the program may be made at any time; however, complete files must be submitted to the Graduate College by January 1 for fall admission.

**International Applicants.** In addition to admission material, international applicants whose native language is not English must submit scores from the Test of English as a Foreign Language. Evidence that sufficient funds are available for financing the student's academic program also must be submitted. See "Admission to the Graduate College," page 85, for more information.

**Advisory Committee.** Typically, by the end of the first year, students form an advisory committee consisting of a chair and two members. The chair and at least one member must be faculty of the School of Justice Studies.

The committee members must be appointed by the dean of graduate studies upon the recommendation of the director of the School of Justice Studies. The advisory committee works with the student to establish a program of study, to direct the thesis or applied project, and to administer the oral examination.

**Program of Study.** The M.S. degree in Justice Studies has two options: a thesis or an applied project. The thesis option requires the completion of 36 semester hours, of which six are thesis hours. The applied project option requires the completion of 42 semester hours, of which three are JUS 593 Applied Project. Each student's program is developed in concert with the advisory committee. The program of study has three major categories: foundation courses, elective courses, and thesis or applied project requirements.

**Foundation Courses.** The required foundation courses provide students with a fundamental understanding of the theo-

ries, methods, and analytic techniques associated with the study of justice. Foundation courses include

JUS 500 Justice Research Methods.....	3
JUS 501 Justice Theory.....	3
JUS 509 Statistical Problems in Justice Research.....	3
JUS 521 Qualitative Data Analysis and Evaluation.....	3

**Elective Courses.** Offered by the School of Justice Studies and other academic units, elective courses develop a unique research area in justice studies. Students may choose these courses in consultation with their advisory committees. Alternatively, students may choose one of the following areas within justice studies:

1. adolescence and justice;
2. American Indian justice;
3. comparative justice;
4. crime and justice;
5. dispute resolution;
6. gender and justice;
7. law, ecology, and society;
8. law, policy, and evaluation;
9. race, ethnicity, and justice; or
10. social and economic justice.

**Thesis Requirements.** To satisfy the research requirement for the Master of Science degree, candidates must write a thesis and defend it in an oral examination.

**Applied Project Requirements.** Candidates pursuing the applied project option must present their applied project and defend it in an oral examination conducted by the faculty member who supervises the project. The project should be an analytical report.

**Concurrent M.A. Anthropology/M.S. Justice Studies.** Graduate students in the School of Justice Studies and the Department of Anthropology are able to receive a concurrent Master of Science degree in Justice Studies and Master of Arts degree in Anthropology with a concentration in sociocultural anthropology. The program is designed for individuals with combined and complementary knowledge and skills. It prepares them for basic and applied research and administrative and educational activities related to justice studies and anthropology. Students must apply and be admitted separately to each program in accordance with the guidelines of the Graduate College, the Department of Anthropology, and the School of Justice Studies.

**Foreign Language Requirements.** None.

**Financial Assistance.** A limited number of assistantships are available on a competitive basis for well-qualified students at the master's level. To be eligible for an assistantship, students must be admitted to a graduate degree program with regular admission status.

### JUSTICE STUDIES (JUS)

#### JUS 500 Justice Research Methods. (3)

once a year

Theories and methods of research with emphasis on development of designs most relevant to justice data and problems.

**JUS 501 Justice Theory. (3)***once a year*

Theories and philosophies of social, economic, political, and criminal justice. Applications of theories to contemporary justice issues. Lecture, discussion.

**JUS 503 Crime and Social Causation. (3)***once a year*

Theories of deviance and crime as they relate to social policies and specific response of the justice complex.

**JUS 509 Statistical Problems in Justice Research. (3)***once a year*

Methodological problems of research design and statistical methods specific to justice studies.

**JUS 521 Qualitative Data Analysis and Evaluation. (3)***once a year*

Analyzes qualitative data, e.g., field notes, in-depth interview transcripts, document analysis, coding, and retrieval with a microcomputer; qualitative evaluation.

**JUS 542 American Indian Justice. (3)***once a year*

Provides a broad overview of American Indian and Alaskan Native issues of justice and injustice in contemporary society.

**JUS 555 Migration/Immigration and Justice. (3)***selected semesters*

Explores the causes and consequences of immigration to the United States and the incorporation of immigrants into the American economy and society. Seminar.

**JUS 560 Women, Law, and Social Control. (3)***once a year*

Gender issues in the exercise of formal and informal mechanisms of social control, including economic, social, legal factors, both violent and nonviolent.

**JUS 570 Juvenile Delinquency. (3)***once a year*

Study of delinquency, including causation theories. Alternative definitions of delinquency, official statistics, and the critique and analysis of the interaction between social institutions and youth.

**JUS 575 Race, Gender, and Crime. (3)***fall and spring*

Current theoretical and methodological debates and controversies regarding race, ethnicity, gender, class, crime, and the criminal justice system; policy implications. Seminar.

**JUS 579 Political Deviance. (3)***once a year*

Seminar examines the politics of deviance by integrating the study of conflict with aspects of social organization, especially state formation.

**JUS 584 Internship. (3 or 6)***fall, spring, summer*

Assignments in a justice agency designed to further the integration of theory and practice. Placements are arranged through consultation with students and agencies.

**JUS 588 Justice and the Mass Media. (3)***once a year*

Analyzes the nature and impact of mass media messages about justice concerns for social order. Lecture, discussion.

**JUS 591 Seminar. (1–3)***once a year*

Topics chosen from various fields of justice studies. May be repeated for credit.

**JUS 593 Applied Project. (1–12)***selected semesters***JUS 610 Law and the Social Sciences. (3)***once a year*

Analyzes the theoretical grounds underlying diverse studies of law and society; creation and administration of law; and jurisprudence and politics.

**JUS 620 Justice Research and Methods. (3)***once a year*

Concept development, research design, data collection strategies, legal research, and building computer databases relevant to the study of justice.

**JUS 630 Data Analysis for Justice Research. (3)***once a year*

Bivariate and multivariate techniques of data analysis and hypothesis testing for justice-related research and use of information and statistical programs.

**JUS 640 Theoretical Perspectives on Justice. (3)***once a year*

Analyzes philosophical perspectives of justice; linkages between social science theory and justice constructs; application of justice to social issues.

**JUS 650 Advanced Qualitative Data Analysis. (3)***spring*

Advanced qualitative data collection and analysis techniques, including ethnography, in-depth interviews, field notes, coding, transcribing, content analysis, textual analysis. Seminar.

**JUS 669 Political Trials and Indigenous Justice. (3)***once a year*

Focuses upon research on political trials, deviance, and conceptions of indigenous and contemporary justice. Lecture, discussion.

**JUS 691 Seminar. (1–3)***fall, spring, summer*

Topics chosen from various fields of justice studies. May be repeated for credit.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 50.

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## Justice Studies

### Interdisciplinary Doctoral Program

[www.asu.edu/copp/justice](http://www.asu.edu/copp/justice)

480/965-7685

WILSN 331

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**Doris Marie Provine, Director, School of Justice Studies**

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The School of Justice Studies offers an interdisciplinary graduate program leading to the Ph.D. degree in Justice Studies. Faculty are from a large number of academic units and provide students with an opportunity to tailor their courses of study to fit individual needs and goals. Committee members represent the College of Law; the Departments of Anthropology, History, Languages and Literatures, Management, Philosophy, Political Science, Psychology, Recreation Management and Tourism, Religious Studies, and Sociology; the Hugh Downs School of Human Communication; and the Schools of Justice Studies, Public Affairs, and Social Work.

### DOCTOR OF PHILOSOPHY

The Ph.D. degree in Justice Studies integrates philosophical, legal, historical, and social science approaches to the study of law and justice in society.

This interdisciplinary program aims to produce scholars whose research activities contribute to the knowledge and understanding of conflicts and dilemmas surrounding social change. Courses on the study of justice are a part of the curriculum of many academic disciplines, and academic books and journals increasingly stress issues of justice and

## GRADUATE PROGRAMS AND COURSES

injustice. In addition to the interdisciplinary programs featuring justice, students may enter academic programs that focus on business administration, class, ecology, gender, law, public administration, and race. Justice Studies graduates from the interdisciplinary Ph.D. program have a strong theoretical background, interdisciplinary training in law, humanities, and the social sciences, and possess the technical skills associated with both qualitative and quantitative research methodologies. These qualifications provide graduates with the opportunity to successfully compete for a variety of positions in academic and justice-related fields.

**Admission.** Applications are reviewed on an annual basis by the Graduate Programs committee. Recommendations for admission are made by the director of the committee to the dean of graduate studies. In addition to meeting minimum Graduate College admission requirements, each applicant must provide a statement of educational and career goals and the reasons for seeking this degree, a sample of written work, and three letters of recommendation, preferably from academic referees. Application to the program may be made at anytime. However, complete files must be submitted to the Graduate College and the School of Justice Studies by January 1 for the following fall semester. Because of enrollment limits, candidates who meet minimum requirements are not automatically admitted.

**Advisory Committee.** An advisory committee consisting of the committee chairperson and at least two other members, must represent a minimum of two disciplines and be from two different academic units. The dean of graduate studies, upon the recommendation of the director of graduate programs, appoints this committee. The advisory committee assists students in developing programs of study, assumes primary responsibility for assessing the students' academic progress, and prepares and evaluates the comprehensive examination.

**Core Courses.** Five core courses are required of all students in the program. The core courses are taken within the first three semesters of the student's program of study. Each core course is interdisciplinary in nature.

JUS 610 Law and the Social Sciences.....	3
JUS 620 Justice Research and Methods .....	3
JUS 630 Data Analysis for Justice Research .....	3
JUS 640 Theoretical Perspectives on Justice.....	3
JUS 650 Advanced Qualitative Data Analysis .....	3
Total .....	15

**Areas of Concentration.** Students use elective courses to develop a specialization in an area relevant to justice studies from a law and social sciences perspective. The specialization is developed through consultation with the student's advisory committee. Five areas of concentration have been established, based on the research and teaching expertise of participating faculty.

1. criminal and juvenile justice;
2. dispute resolution;
3. law, justice, and minority populations;
4. law, policy, and evaluation; and
5. women, law, and justice.

From these broad concentrations, students can develop areas of study emphasizing

1. adolescence and justice;
2. American Indian justice;
3. comparative justice;
4. crime and justice;
5. dispute resolution;
6. gender and justice;
7. law, ecology, and society;
8. law, policy, and evaluation;
9. race, ethnicity, and justice; and
10. social and economic justice.

Students may develop other areas of study in consultation with their advisory committee.

**Program of Study.** Students entering the program with a master's degree in the social sciences, philosophy, a relevant interdisciplinary field, or a Juris Doctor (J.D.), must complete a minimum of 54 semester hours of study beyond the master's or J.D. degree, including 24 semester hours of dissertation and research. Applicants holding only the baccalaureate degree are required to complete a total of 84 semester hours. At least 30 hours of the approved Ph.D. program of study must be completed after admission into the program. The Graduate College also requires that two consecutive semesters, subsequent to admission to the program, must be spent in full-time residence at ASU.

**Foreign Language Requirements.** None.

**Comprehensive Examination.** Upon completion of course work and before the start of dissertation research, the student is given a written examination. The examination evaluates the student's accumulation of interdisciplinary knowledge and ability to communicate across disciplines. The exam is developed and administered by the student's advisory committee.

**Dissertation Committee.** After passing the comprehensive examination, a dissertation committee is formed and approved by the dean of graduate studies upon the recommendation of the director of graduate programs. The dissertation committee must consist of at least three faculty members, including the dissertation committee chair. At least one member of the dissertation committee must be a faculty member from the School of Justice Studies. The three-member committee must represent at least two disciplines and two different academic units. The dissertation and advisory committees may have different memberships.

**Advancement to Candidacy.** Ph.D. students will achieve candidacy status in a letter from the Graduate College dean upon (1) passing the comprehensive examination, and (2) successfully defending the dissertation prospectus.

**Dissertation Requirements.** The dissertation consists of a fully documented written analysis demonstrating an appropriate level of interdisciplinary skills and competence associated with a justice issue. Each student must register for a minimum of 24 semester hours of dissertation and research,

12 of which must be completed in semesters following the one in which the student is advanced to candidacy.

**Final Examination.** The dissertation must be defended in an oral examination. A candidate must pass the final examination within five years after completing the comprehensive examination.

**Concurrent Ph.D. in Justice Studies/J.D.** The purpose of the concurrent Ph.D. in Justice Studies/J.D. is to provide a rigorous education for highly qualified students interested in pursuing academic careers in law, law and the social sciences, or law and philosophy. To seek concurrent degrees, the prospective student must first gain separate admission to the College of Law and the interdisciplinary Ph.D. program in Justice Studies. The student must then obtain special approval to pursue concurrently the J.D. and Ph.D. degrees. No more than three students a year are admitted into the concurrent degree program.

### COURSES

For courses, see "Justice Studies (JUS)," page 248.

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## Kinesiology

### Master's Programs

[www.asu.edu/clas/kines](http://www.asu.edu/clas/kines)

480/965-3591

PEBW 218

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**Daniel M. Landers, Interim Chair**

**Regents' Professor:** Landers

**Professors:** Darst, Matt, Pangrazi, Stelmach

**Associate Professors:** Hinrichs, Morgan, Treasure, Willis

**Assistant Professors:** Etnier, Kulinna, Ringenbach, Santello

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The faculty in the Department of Kinesiology offer graduate programs leading to the M.S. degree in Kinesiology and the Master of Physical Education. Faculty also participate in two interdisciplinary Ph.D. programs: (1) Exercise Science with concentrations in biomechanics, motor behavior/sport psychology, and physiology of exercise, and (2) Curriculum and Instruction with a concentration in physical education.

The Committee on Exercise Science offers an interdisciplinary graduate program leading to the Ph.D. degree in Exercise Science. The present committee is composed of members from several academic units. For more information about this program, see "Exercise Science," page 220.

The Committee on Curriculum and Instruction offers an interdisciplinary graduate program leading to the Ph.D. degree in Curriculum and Instruction. For more information, see "Curriculum and Instruction," page 174.

## MASTER OF SCIENCE

Applicants for the M.S. degree program in Kinesiology may choose from five areas of study: biomechanics, exercise physiology, physical education (elementary, secondary, and adapted), motor behavior (motor learning and control, motor development), and sport and exercise psychology. All applicants are required to submit scores from the Graduate Record Examination (GRE). Admission decisions are based upon previous academic training and performance, GRE scores, recommendations, and the ability of potential mentors to devote time to an additional student. International applicants whose native language is not English must also submit a Test of English as a Foreign Language score. Applications are reviewed by department faculty only once a year. To be considered for admission in the fall semester, all application materials must be received by the department by December 1. The program requires a minimum of 30 semester hours, at least 21 of which must be KIN courses. Required courses with corresponding semester hours include KIN 500 (three), 501 (three), and 599 (six). Remaining course work is selected by the student in consultation with an advisor and supervisory committee.

**Deficiencies.** All applicants recommended for admission are evaluated for deficiencies in their academic preparation. Deficiencies are divided into two areas: (1) those associated with the discipline of kinesiology (human anatomy and physiology, biomechanics, exercise physiology, motor learning and development, and psychosocial aspects of physical activity) and (2) those associated with the area of study (a maximum of six deficiency semester hours pertinent to study may be specified).

**Foreign Language Requirements.** None.

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

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

## MASTER OF PHYSICAL EDUCATION

The faculty in the Department of Kinesiology offer a program leading to the Master of Physical Education (M.P.E.) degree. The M.P.E. degree is designed to prepare scholarly professionals (i.e., teachers of physical education). Emphasis is placed on improving instructional effectiveness and developing a quality physical education curriculum in a school setting. Three areas of study are available: elementary, secondary, and adapted physical education.

**Admission.** Applicants who hold a bachelor's degree in education and who are certified to teach may apply to the M.P.E. degree directly. Applicants with a bachelor's degree in physical education but who are not certified to teach apply to the postbaccalaureate/M.P.E. degree. Deficiencies are assessed where applicable.

**Program of Study.** A minimum of 33 semester hours of course work is required for the M.P.E. program, with 18 semester hours of required core courses, six semester hours of cognate area courses, and nine hours of recommended electives. A total of 58 semester hours is required of



## GRADUATE PROGRAMS AND COURSES

students completing both the postbaccalaureate program and the M.P.E.

**Foreign Language Requirements.** None.

**Final Examination.** A final written comprehensive examination is required.

### KINESIOLOGY (KIN)

#### **KIN 400 Teaching Physical Activity Concepts. (3)**

*fall and spring*

Analyzes and critiques teaching concepts, principles, and skills outlined in Arizona Physical Activity Standards. Evaluates national guidelines for promoting physical activity. Prerequisites: ENG 101 (or 107), 102 (or 108); KIN 200 (or its equivalent).

#### **KIN 413 Qualitative Analysis in Sport Biomechanics. (3)**

*spring*

Develops systematic approach for detecting and correcting errors in human performance using anatomical and mechanical principles. Lecture, lab. Prerequisite: KIN 335.

#### **KIN 414 Electromyographic Kinesiology. (3)**

*spring*

Muscular contributions to human movement, muscle mechanics, electrophysiological basis, and practical application of electromyography. Lecture, discussion. Fee. Prerequisites: KIN 335, 340; instructor approval.

#### **KIN 421 Human Motor Control. (3)**

*spring*

Focuses on understanding how the human central nervous system controls, regulates, and learns movements. Prerequisite: KIN 345 or instructor approval.

#### **KIN 422 Motor Control in Special Populations. (3)**

*spring*

Discusses principles of motor control theories and related practical applications for certain special developmental populations. Lecture, discussion. Cross-listed as PSY 422. Credit is allowed for only KIN 422 or PSY 422. Prerequisite: KIN 345.

#### **KIN 423 Motor Control and Aging. (3)**

*spring*

Functional and behavioral changes to the motor control system as humans age, how specifically it impacts motor control and learning. Prerequisite: KIN 345 or instructor approval.

#### **KIN 442 Fuel Metabolism. (3)**

*fall*

Discusses current research concerning the metabolism of carbohydrate, fat, and protein during exercise. Credit is allowed for only KIN 442 or 536. Prerequisite: KIN 340 or instructor approval.

#### **KIN 444 Metabolic Adaptations to Exercise Training. (3)**

*summer*

Examines physiologic adaptations to exercise training as they relate to metabolism and tissue functions. Prerequisite: KIN 340.

#### **KIN 445 Exercise Physiology for Children and Adolescents. (3)**

*spring*

Understanding the influence of physical growth and maturation on the development of the functional capacities of the exercising child. Credit is allowed for only KIN 445 or 535. Lecture, discussion. Prerequisite: KIN 340 or 530 or instructor approval.

#### **KIN 450 Biopsychosocial Perspectives on Physical Activity and Health. (3)**

*fall*

Uses a biopsychosocial perspective to examine the interrelationships on physical activity and health (physical and mental). Prerequisite: KIN 352.

#### **KIN 452 Exercise Psychology. (3)**

*spring*

Contemporary research and theory as related to human behavior and health in an exercise setting. Prerequisite: KIN 352.

#### **KIN 460 Theory of Strength Training. (3)**

*fall*

Research and theories on developing muscular strength; programs for developing muscular strength. Lecture, discussion. Prerequisites: KIN 335, 340.

#### **KIN 500 Research Methods. (3)**

*fall*

Introduces the basic aspects of research, including problem selection, literature review, instrumentation, data handling, methodology, and the writing of research reports and articles.

#### **KIN 501 Research Statistics. (3)**

*spring*

Statistical procedures; sampling techniques; exercise testing, exercise prescription, hypothesis testing, and experimental designs as they relate to research publications.

#### **KIN 505 Applied Exercise Physiology Techniques. (3)**

*fall*

Investigative techniques used in the applied exercise physiology laboratory. Emphasizes pulmonary function, body composition, and cardiorespiratory assessment. Lecture, lab. Prerequisite: KIN 340.

#### **KIN 510 Introduction to Biomechanics Research Methods. (3)**

*fall*

Applies mechanics to human movement analysis. Includes consideration of 2-D imaging techniques, force measurement, electromyography, and data processing methods. Lecture, discussion, some labs. Prerequisite: KIN 335 or instructor approval.

#### **KIN 512 Biomechanics of the Skeletal System. (3)**

*fall*

Biomechanics of tissues, structures, and major joints of the musculoskeletal system. Discusses injury mechanisms. Lecture, discussion, some labs. Prerequisite: KIN 335 or instructor approval.

#### **KIN 520 Sport Psychology. (3)**

*fall*

Current research in sport psychology with an emphasis on performance enhancement. Includes questionnaire, psychophysiological, and behavioral research methods. Lecture, discussion. Prerequisites: KIN 448, 500.

#### **KIN 521 Motor Development, Control, and Learning. (4)**

*spring*

Theory and research on motor skill acquisition, including learning/control and development (i.e., growth, children and exercise, and development learning). Lecture, discussion, some labs. Prerequisites: KIN 345, 500, 501.

#### **KIN 522 Exercise Psychology. (3)**

*spring*

Contemporary research and theory as related to human behavior and health in an exercise setting. Lecture, discussion. Prerequisite: KIN 500.

#### **KIN 524 Motivation in Sport and Exercise. (3)**

*fall*

Focuses on various issues in human motivation, identifying basic processes and examining their application in sport, exercise, and physical education.

#### **KIN 530 Exercise Physiology. (3)**

*fall*

Immediate and long-term adaptations to exercise with special reference to training and the role of exercise in cardiovascular health. Prerequisite: KIN 340.

#### **KIN 531 Physiology of Women in Sport. (3)**

*spring*

Physiological aspects of women engaging in physical activity. Emphasizes factors affecting performance and health throughout life. Prerequisite: KIN 340.

#### **KIN 532 Exercise Biochemistry. (3)**

*fall*

Understanding the basic biochemical principles and enzyme pathways involved in energy transduction during exercise. Lecture, discussion. Prerequisite: KIN 340 or instructor approval.

#### **KIN 533 Exercise Endocrinology. (3)**

*fall*

Discusses current research and theory concerning hormonal changes during exercise. Lecture, discussion. Prerequisite: KIN 340 or instructor approval.

#### **KIN 535 Exercise Physiology for Children and Adolescents. (3)**

*spring*

Understanding the influence of physical growth and maturation on the development of the functional capacities of the exercising child. Credit

is allowed for only KIN 535 or 445. Lecture, discussion. Prerequisite: KIN 340 or 530 or instructor approval.

**KIN 536 Fuel Metabolism. (3)**

*fall*

Discusses current research concerning the metabolism of carbohydrate, fat, and protein during exercise. Credit is allowed for only KIN 536 or 442. Prerequisite: KIN 340 or instructor approval.

**KIN 561 Administration of Athletics. (3)**

*selected semesters*

Managing an athletic program, including financing, budget policies, staging, and promotion of athletic contests, schedules, travel insurance, and current athletic trends.

**KIN 570 Programs and Special Topics in Adapted Physical Education. (3)**

*fall and spring*

Contemporary adapted, developmental, remedial, and corrective physical education programs; understanding of principles, problems, and recent developments in this area.

**KIN 572 Trends and Issues in Physical Education. (3)**

*spring*

Literature, research, and practices in contemporary physical education, including finances, Title IX, teaching and coaching philosophies, school organization, and nonteaching physical education programs.

**KIN 573 Curriculum and Instruction in Secondary Physical Education. (3)**

*fall and spring*

Current curriculum and instruction practices and research in secondary school physical education. Prerequisite: Kinesiology major or teaching experience.

**KIN 576 Physical Education for Elementary School Children. (3)**

*fall and spring*

Current practices and research pertaining to elementary school physical education programs.

**KIN 578 Student Teaching in Secondary Schools. (6–12)**

*fall and spring*

Practice of teaching. Relationship of theory and practice in teaching. Fee. Prerequisite: completion of all required course work (or its equivalent) before student teaching.

**KIN 599 Thesis. (1–12)**

*selected semesters*

**KIN 610 Advanced Topics in Biomechanics. (3)**

*spring*

3-D imaging techniques, data analysis theory, and integration of biomechanics research tools; includes original research project. Lecture, discussion, some labs. Prerequisite: KIN 510 or instructor approval.

**KIN 621 Motor Learning/Control. (3)**

*fall*

Discussion of contemporary research issues in motor learning and control. Includes behavioral and neurophysiological issues. Lecture, discussion. Prerequisite: KIN 521.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 50.

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## Languages and Literatures

### Master's and Doctoral Programs

[www.asu.edu/clas/dll](http://www.asu.edu/clas/dll)

480/965-6281

LL 440

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#### Deborah N. Losse, Chair

**Regents' Professors:** Foster, Keller

**Professors:** Alexander, Baldini, Ballon-Aguirre, Chambers, Croft, Carlos Garcia-Fernández, Honegger, Horwath, Losse, Volek, Wetsel, Williams, T. Wong

**Associate Professors:** Acereda, Candela, Canovas, Choi, Colina, Carmen Garcia-Fernández, Hernández-G., Lafford, Orlich, Ossipov, Rees, Reiman, Sanchez, Suwarno, Tompkins, Urioste-Azcorra, Vitullo

**Assistant Professors:** Cashman, George, Gilfillan, Ginsburg, Gruzinska, Haberman, Siegel-Valdes

**Senior Lecturer:** Foard

**Lecturers:** Deal, Hendrickson, Lage, Le, Martinez, Oh, Pang, Petersen, Poudrier, Shimomura, Siriprakob, Stiffel, Walton-Ramirez, E. Wong, Zhang

**Academic Associate:** Glessner-Calkins

**Research Associate Professor:** Sipka

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The faculty in the Department of Languages and Literatures offer graduate programs leading to the M.A. degree in Asian Languages and Civilizations—Chinese/Japanese, French, German, and Spanish. For concentrations available under each major, see the "College of Liberal Arts and Sciences Graduate Degrees and Majors" table, page 77.

Students admitted to the Master of Education degree program in Secondary Education may elect foreign languages as the subject matter field. See "Master of Education," page 189, for information on the Master of Education degree.

The faculty also offer a graduate program leading to the Ph.D. degree in Spanish. See "Doctor of Philosophy," page 96, for general requirements.

It is recommended, but not required, that students applying for admission to the M.A., M.Ed., or Ph.D. program submit scores on the Graduate Record Examination.

The department also offers a Certificate in Translation.

#### MASTER OF ARTS

Candidates for the M.A. degree should, upon entrance, present the equivalent of an undergraduate major in the language in which the degree is sought. Those who lack this background, but who show strong potential and meet Graduate College admissions requirements, may be admitted to a

## GRADUATE PROGRAMS AND COURSES

graduate program on a provisional basis, pending removal of specified deficiencies. These deficiencies must be completed in addition to the regular program of study for the master's degree.

Students in all graduate programs are expected to maintain a high level of linguistic fluency acceptable to a native speaker. Before acceptance in the program, applicants may be requested to furnish evidence of their proficiency.

The program of study for the M.A. degree includes a minimum of 30 semester hours of graduate-level work, as approved by the candidate's supervisory committee. The program must include a 500-level Bibliography and Research Methods course offered by the department. When approved by the candidate's supervisory committee, in some programs, nine hours in another language or in closely related courses may be included in the program.

Students who are primarily interested in teaching on the secondary or community college levels may select a program of study with a concentration in language and cultures. Students seeking an M.A. degree in Asian Languages and Civilization or in Spanish, should consult with the respective director of Graduate Studies.

**Comprehensive Examination.** All candidates are required to pass a comprehensive written or oral examination designed to evaluate the candidate's knowledge in the area of specialization. A reading list is provided as a guide to preparation for this examination.

**Thesis Requirements.** There are two options. The thesis option is required for students intending to pursue doctoral studies. In French, there is an applied project option for students intending to teach in K-12 or the community colleges; however, such students may also choose the thesis option. See the director of graduate studies to inquire about the two options. A thesis is required of students seeking an M.A. degree in Spanish. Consult the *Spanish Graduate Handbook* for more information.

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

### DOCTOR OF PHILOSOPHY

The Ph.D. degree is offered with a major in Spanish with concentrations in literature or cultural studies.

**Program of Study.** A student's individual program of courses covering the various periods of Spanish and Latin American literature and/or culture, as well as the historical and political background of both areas, is determined in consultation with the supervisory committee. Specifically required as prerequisites are SPA 500 Bibliography and Research Methods, SPA 545 Concepts of Literary Criticism (for a concentration in literature), and SPA 598 ST: Cultural Studies/Semiotics of Culture (for a concentration in cultural studies).

At least 15 graduate credits must be earned in the subfield, and the candidate's program of study in the subfield must be approved by the subfield department. Normally the comprehensive examination on the subfield, administered by the subfield department, must be satisfied before the

comprehensive examination in Spanish. Students are urged to consult the *Spanish Graduate Handbook*.

**Foreign Language Requirements.** Each candidate is expected to demonstrate a reading knowledge of two languages other than Spanish. The language requirements must be satisfied before the candidate is eligible to take the comprehensive examination.

**Comprehensive Examination.** A written and oral comprehensive examination, designed to ascertain the candidate's knowledge and orientation in the field of study and competency to proceed with the dissertation, is required at or near the end of course work.

**Dissertation Requirements.** The candidate must present an acceptable dissertation based on original investigation. The dissertation must represent a significant contribution to knowledge and demonstrate the candidate's ability to do independent, scholarly research.

**Final Examination.** A final oral examination is required. This examination covers the subject matter of the dissertation and appropriate field.

### UNDERGRADUATE CERTIFICATE IN TRANSLATION

The Department of Languages and Literatures offers an undergraduate certificate in translation. The certificate may be of personal or professional interest to graduate students. For more information, see the ASU *General Catalog* (accessible on the Web at [www.asu.edu/catalog](http://www.asu.edu/catalog)).

### RESEARCH ACTIVITY

Faculty in the Department of Languages and Literatures conducts a wide array of research on topics relating to languages and cultures of the world. Of particular interest are contemporary and urban topics relating to the 20th-century and beyond, with special emphasis on urban studies, gender issues/sexual identities, popular culture, film, theater, and print media. Current pedagogical issues relating to language acquisition figures prominently in the department, as do technological developments. These include the teaching of languages and cultures, and the accessibility to and distribution of information regarding regions and topics of interest to faculty and students.

**Asian Languages and Civilizations Research Activity.** Within the two areas of China and Japan, the research activity of the faculty in Asian Languages and Civilizations covers a range of disciplines. These include historical as well as applied linguistics (especially language pedagogy), literary history and theory, and literary translation. Current research of the faculty explores such areas as Japanese sinology, the use and transformation of Chinese characters in Japan, premodern and modern fiction in both China and Japan, and the Chinese tradition of pastime fiction.

**Spanish Research Activity.** In addition to broad coverage of peninsular and Spanish-American literary and cultural topics, particular regional emphases lie within the U.S. Southwest, Mexico, Central America, the Caribbean, the Andes, and the River Plate. Specific research projects by

Spanish faculty members include topics in Chicano and Latino literature, literary translation, Hispanic literary bibliography, contemporary literary theory, Spanish-American colonial literature, Argentine narrative, contemporary Mexican and Centro-American literature, contemporary Spanish and Spanish-American poetry, Spanish-American oral tradition, Hispanic women writers, Latin American popular culture, Spanish-American Jewish writers, gender and queer studies, contemporary Spanish and Spanish-American theater and film, Spanish-American postmodern culture, prose narrative of the Golden Age, Hispanic linguistics and bilingualism/sociolinguistics, second language acquisition, applied linguistics, discourse analysis, and various topics in Brazilian literature.

**CHINESE (CHI)**

**CHI 500 Bibliography and Research Methods. (3)**

*selected semesters*  
Introduces research materials on China in Chinese, Japanese, and Western languages. Overview of research methods. Lecture, discussion.

**CHI 514 Advanced Classical Chinese. (3)**

*selected semesters*  
Close readings in selected premodern texts, with focus on special grammatical features, and increased vocabulary. Lecture, discussion.

**CHI 520 Teaching of Chinese as a Second Language. (3)**

*selected semesters*  
Theory and practice of teaching Chinese, including presentation, interaction, and evaluation, with consideration given to cultural factors. Lecture, discussion.

**CHI 535 Advanced Readings. (3)**

*selected semesters*  
Readings in primary and secondary sources in history, art, religious studies, economics, or other fields. Lecture, discussion.

**CHI 543 Chinese Language and Linguistics. (3)**

*fall*  
Analysis and discussion, within the framework of linguistic theory, of selected problems in Chinese phonetics, morphology, and syntax. Lecture, discussion.

**CHI 585 Problems of Translation. (3)**

*selected semesters*  
Theories and practice of translation: strategies for handling a variety of Chinese texts. Lecture, discussion.

**CHI 591 Seminar. (3)**

*selected semesters*  
Topics in literary, linguistic, or cultural studies.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 50.

**FOREIGN LANGUAGES (FLA)**

**FLA 461 Feminist Political Writing in Contemporary Europe. (3)**

*selected semesters*  
Examines the discourse of gender-politics in Central Eastern Europe before and after Soviet hegemony. Cross-listed as ENG 429. Credit is allowed for only ENG 429 or FLA 461.

**FLA 464 Politics of Drama in 20th-Century Europe. (3)**

*selected semesters*  
Interdisciplinary examination of European drama before and after WWII. Cross-listed as ENG 429. Credit is allowed for only ENG 429 or FLA 464.

**FLA 472 Literature and Politics in Pre- and Post-Communist Europe. (3)**

*selected semesters*  
Interdisciplinary examination of the cultures of Eastern Europe from WWI to the present. Cross-listed as ENG 429. Credit is allowed for only ENG 429 or FLA 472.

**FLA 476 Literature and Film in 20th-Century Eastern Europe. (3)**  
*selected semesters*

Evaluates literary texts and films as a massive propaganda machine of the totalitarian state. Cross-listed as ENG 429. Credit is allowed for only ENG 429 or FLA 476.

**FLA 515 Second Language Acquisition. (3)**

*spring*  
Discussion and application of theories of second language acquisition. Prerequisite: FLA 400 (or its equivalent).

**FLA 525 Trends and Issues in Foreign Language Teaching. (3)**  
*selected semesters*

Advanced methods seminar, designed for experienced teachers.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 50.

**FRENCH (FRE)**

**FRE 421 Structure of French. (3)**

*fall*  
Phonology, morphology, syntax, semantics, and varieties of French. Prerequisites: both FRE 311 and 312 or only instructor approval.

**FRE 422 Applied French Linguistics. (3)**

*spring*  
Applies linguistic theory and second language acquisition theory to teaching of French. Prerequisite: ASB 480 or ENG 213 or FLA 400.

**FRE 423 French Syntax. (3)**

*spring*  
Analyzes French syntactic structure by contemporary theoretical models. Prerequisite: ASB 480 or ENG 213 or FLA 400.

**FRE 432 Gay Identities in Modern French Literature. (3)**

*spring*  
Examines the representation of homosexuals as well as the emergence of homosexuality as a theme in modern French literature. Lecture, discussion. Prerequisites: both FRE 322 and 6 hours of 300-level French or only instructor approval.

**FRE 441 French Literature of the 17th Century. (3)**

*fall*  
From 1600 to 1660. Prerequisites: both FRE 321 and 6 hours of 300-level French or only instructor approval.

**FRE 442 French Literature of the 17th Century. (3)**

*spring*  
From 1660 to 1700. Prerequisites: both FRE 321 and 6 hours of 300-level French or only instructor approval.

**FRE 445 French Literature of the 18th Century. (3)**

*selected semesters*  
Contributions of the philosophers and the development of the novel and drama. Prerequisites: both FRE 321 and 6 hours of 300-level French or only instructor approval.

**FRE 451 French Poetry of the 19th Century. (3)**

*spring*  
From Romanticism to Parnassian poetry to Symbolism. Prerequisites: both FRE 322 and 6 hours of 300-level French or only instructor approval.

**FRE 452 French Novel of the 19th Century. (3)**

*fall*  
From Constant, Hugo, Balzac, Stendhal, and Sand to Flaubert and Zola, with emphasis on major literary movements. Prerequisites: both FRE 322 and 6 hours of 300-level French or only instructor approval.

**FRE 453 Theater of the 19th Century. (3)**

*spring*  
From Romantic drama to the Symbolist Theater. Representative plays of Hugo, Musset, Vigny, Dumas, Becque, Rostand, Feydeau, and Mirbeau. Prerequisites: both FRE 322 and 6 hours of 300-level French or only instructor approval.

**FRE 461 Modern Narrative. (3)**

*fall*  
Representative authors from Gide to the new Nouveau Roman. Prerequisites: both FRE 322 and 6 hours of 300-level French or only instructor approval.

## GRADUATE PROGRAMS AND COURSES

### **FRE 462 Modern Poetry. (3)**

*spring*

Representative authors from Mallarmé to Bonnefoy. Lecture, discussion. Prerequisites: both FRE 322 and 6 hours of 300-level French or only instructor approval.

### **FRE 471 The Literature of Francophone Africa and the Caribbean. (3)**

*fall*

Selected prose, poetry, and drama of black authors from Africa and the Caribbean. Prerequisites: both FRE 322 and 6 hours of 300-level French or only instructor approval.

### **FRE 472 Franco-Canadian Civilization. (3)**

*spring*

Study of the civilization of Quebec in particular through its history, language, literature, music, and customs. Prerequisite: 9 hours of 300-level French or instructor approval.

### **FRE 480 Translation Theory and Practice. (3)**

*spring*

Theoretical and practical approaches to the fundamentals of meaning-based translation. Lecture, seminar. Prerequisite: FRE 412 or instructor approval.

### **FRE 485 Literary Translation. (3)**

*spring*

Theory and practice of literary translation with emphasis on application through individual translation project. Prerequisite: FRE 480.

### **FRE 500 Research and Critical Methods. (3)**

*fall*

Overview of major critical and theoretical frameworks used to study French and Francophone literature. Required of all French graduate students in French literature.

### **FRE 510 Introduction to Textual Analysis. (3)**

*fall*

Introduces various oral and written techniques aimed at explicating literary texts. Required of all French graduate students focusing on literature. Lecture, discussion.

### **FRE 521 History of the French Language. (3)**

*spring*

Principal phonological, morphological, and semantic developments of French from Latin to present, with emphasis on Old and Middle French. Prerequisite: some familiarity with Latin recommended.

### **FRE 531 Medieval French Literature. (3)**

*fall*

Readings in the epics, early drama, Roman courtois, and other representative literary genres of the Middle Ages.

### **FRE 535 Identity, Gender, and Society in Early Modern French Literature. (3)**

*fall*

Readings in French Renaissance literature with special focus on Rabelais, Montaigne, Marguerite de Navarre. Lecture, discussion.

### **FRE 580 Translation Theory and Practice. (3)**

*spring*

Theoretical and practical approaches to the fundamentals of meaning-based translation. Lecture, seminar. Prerequisite: FRE 412 or instructor approval.

### **FRE 585 Literary Translation. (3)**

*spring*

Theory and practice of literary translation with emphasis on application through individual translation project. Lecture, seminar. Prerequisite: FRE 480.

### **FRE 591 Seminar. (1–12)**

*selected semesters*

Topics may include the following:

- Advanced Problems in French Literature. (3)
- Balzac. (3)
- Corneille, Molière, and Racine. (3)
- Diderot, Voltaire, and Rousseau. (3)
- Flaubert. (3)
- French Existentialist Literature. (3)
- French Literary Criticism. (3)
- Proust. (3)
- Realism and Naturalism. (3)
- Romanticism. (3)
- Stendhal and Zola. (3)

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see “Omnibus Courses,” page 50.

## GERMAN (GER)

### **GER 421 German Literature. (3)**

*fall*

From the beginning to Classicism. Prerequisite: 6 hours of 300-level German.

### **GER 422 German Literature. (3)**

*spring*

From Romanticism to the present. Prerequisite: 6 hours of 300-level German.

### **GER 453 German Literary Masterpieces on Film. (3)**

*fall, spring, summer*

Film and literature in their correlation to each other and to cultural, political, and social trends in German-speaking countries. Special arrangements for graduate students and those without a knowledge of German. Lecture, discussion.

### **GER 500 Bibliography and Research Methods. (3)**

*selected semesters*

Required of all graduate students.

### **GER 521 History of German Language. (3)**

*selected semesters*

Linguistic development of German from the earliest records to the present.

### **GER 523 German Drama. (3)**

*selected semesters*

Drama of the 19th and 20th centuries.

### **GER 527 The *Novelle*. (3)**

*selected semesters*

Special studies in the German short story.

### **GER 591 Seminar. (1–12)**

*selected semesters*

Special topics are concerned with a figure, theme, or work in German literature or Germanic studies. Topics may include the following:

- Faust. (3)
- Germanic Studies. (3)
- Goethe. (3)
- Grass and Böll. (3)
- Hesse. (3)
- Kafka. (3)
- Kleist. (3)
- Schiller. (3)

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see “Omnibus Courses,” page 50.

## JAPANESE (JPN)

### **JPN 500 Bibliography and Research Methods. (3)**

*selected semesters*

Introduces research materials on Japan both in Japanese and in Western languages. Overview of research methods. Lecture, discussion.

### **JPN 514 Advanced Premodern Japanese. (3)**

*selected semesters*

Close readings of selected premodern texts, with focus on grammatical and stylistic features. Lecture, discussion. Prerequisite: JPN 414 (or its equivalent).

### **JPN 520 Teaching of Japanese as a Second Language. (3)**

*selected semesters*

Theory and practice of teaching Japanese, including presentation, interaction, and evaluation, with consideration given to cultural factors. Lecture, discussion.

### **JPN 535 Advanced Readings. (3)**

*selected semesters*

Readings in primary and secondary sources in history, art, religious studies, literature, or other fields. Lecture, discussion. Prerequisite: JPN 414 (or its equivalent).

**JPN 543 Japanese Language and Linguistics. (3)**

*selected semesters*

Analysis and discussion of linguistic theories applied to Japanese phonology, morphology, and syntax, including psychological, sociological, and historical aspects.

**JPN 585 Advanced Problems of Translation. (3)**

*selected semesters*

Theories and practice of translation; strategies for handling a variety of Japanese texts. Lecture, discussion. Prerequisite: JPN 435 (or its equivalent).

**JPN 591 Seminar. (3)**

*selected semesters*

Topics in literary, linguistic, or cultural studies.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 50.

**RUSSIAN (RUS)**

**RUS 591 Seminar. (3)**

*selected semesters*

Topics in literary, linguistic, or other cultural studies.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 50.

**SPANISH (SPA)**

**SPA 500 Bibliography and Research Methods. (3)**

*fall*

Required of all graduate students.

**SPA 536 Generation of 1898. (3)**

*selected semesters*

Works of Unamuno, Baroja, Azorín, and their contemporaries, studied against the ideological background of the turn of century in Spain.

**SPA 540 History of the Spanish Language. (3)**

*spring*

Analyzes and discusses the development of Spanish from Vulgar Latin to the present day. Prerequisite: FLA 400 (or its equivalent).

**SPA 541 Spanish Language in America. (3)**

*fall*

Discusses and analyzes various regional and social varieties of Spanish in the Americas. Prerequisite: FLA 400 (or its equivalent).

**SPA 542 Studies in the Spanish of the Southwest. (3)**

*spring*

Examines bilingualism and the social and regional dialects of Spanish in the Southwest. Prerequisite: FLA 400 (or its equivalent).

**SPA 543 Structure of Spanish. (3)**

*spring*

Analyzes and discusses data on selected topics in Spanish morphology, semantics, and syntax. Prerequisite: FLA 400 (or its equivalent).

**SPA 544 Spanish Phonology. (3)**

*spring*

Surveys problems of Spanish phonology within the context of recent phonological theory. Prerequisite: FLA 400 (or its equivalent).

**SPA 545 Concepts of Literary Criticism. (3)**

*spring*

Aims and methods of modern literary scholarship. Discusses major theories of literary analysis.

**SPA 555 Spanish American Modernism. (3)**

*selected semesters*

Principal works and figures of literary modernism, 1880–1920, with emphasis on international literary context of the movement.

**SPA 557 Contemporary Spanish American Poetry. (3)**

*selected semesters*

Major works and problems in contemporary poetry and poetics, with emphasis on Paz, Parra, Cardenal, and new poetry since 1960.

**SPA 560 Medieval Spanish Literature. (3)**

*selected semesters*

Major figures and works of the Middle Ages in Spain.

**SPA 561 Golden Age Spanish Prose Fiction. (3)**

*selected semesters*

Major figures and works of the 16th and 17th centuries, with emphasis on the picaresque novel.

**SPA 562 Golden Age Spanish Poetry. (3)**

*selected semesters*

Major figures and works of the 16th and 17th centuries, with emphasis on lyric poetry.

**SPA 563 Spanish Romanticism. (3)**

*selected semesters*

Principal figures and works of Spanish romanticism, with emphasis on international literary context of the movement.

**SPA 564 19th-Century Spanish Prose Fiction. (3)**

*selected semesters*

Principal figures and works of realism in the 19th-century novel, with emphasis on Galdós.

**SPA 565 20th-Century Spanish Drama. (3)**

*selected semesters*

Principal figures and works of Spanish dramatic literature from the Generation of 1898 to the present.

**SPA 566 Generation of 1927. (3)**

*selected semesters*

Major poets of the Generation of 1927, with emphasis on works of Lorca, Guillén, Salinas, and Aleixandre.

**SPA 567 Contemporary Spanish Novel. (3)**

*selected semesters*

Major works of post-Civil War Spanish fiction.

**SPA 568 Cervantes. (3)**

*selected semesters*

Extensive analysis of the prose and theater of Cervantes as a key figure of the Spanish Golden Age. Lecture, seminar.

**SPA 570 Indigenous Literatures of Spanish America. (3)**

*selected semesters*

Indigenous literary traditions, with emphasis on Nahuatl, Mayan, and Quechua literatures through readings in Spanish translations.

**SPA 571 Colonial Spanish American Literature. (3)**

*selected semesters*

Major figures and works from conquest to independence.

**SPA 572 Spanish American Drama. (3)**

*selected semesters*

Major contributions of Spanish American drama, with emphasis on contemporary dramatists.

**SPA 573 Spanish American Essay. (3)**

*selected semesters*

Major works of the essay, within the framework of intellectual history and literary movements.

**SPA 574 Spanish American Vanguard Poetry. (3)**

*selected semesters*

Examines poetic developments, 1920–1940, with emphasis on Huidobro, Vallejo, Neruda, and the international context of their works.

**SPA 575 Contemporary Spanish American Novel. (3)**

*selected semesters*

Principal novels of the *Nueva Narrativa Hispanoamericana*, within the context of contemporary theories of the narrative.

**SPA 576 Contemporary Spanish American Short Story. (3)**

*selected semesters*

Principal short stories of the *Nueva Narrativa Hispanoamericana*, within the context of contemporary theories of the narrative.

**SPA 577 Regional Spanish American Literature. (3)**

*selected semesters*

Figures and works of major national (Peru, Argentina, Chile, and Mexico) and regional (Caribbean) literatures. Topics offered on a rotating basis. May be repeated when topics vary.

**SPA 578 Novel of the Mexican Revolution. (3)**

*selected semesters*

Representative works and authors of this genre (Guzmán, Azuela, Urquiza, Muñoz, and Romero), including related or peripheral offshoots in indigenous novels.

**SPA 581 Latin American Popular Culture. (3)**

*selected semesters*

Studies in selected topics of Latin American popular culture, with emphasis on appropriate academic models for the critical analysis of these materials.

## GRADUATE PROGRAMS AND COURSES

### SPA 582 Studies in Latin American Film. (3)

*selected semesters*

Examines the role of film in contemporary Latin American culture; films viewed and analyzed as casebook examples. Seminar.

### SPA 583 Latin American Feminist Filmmaking. (3)

*selected semesters*

Examines major Latin American films grounded in theories of women's lives. Seminar.

### SPA 591 Seminar. (3)

*selected semesters*

Spanish and Spanish American literary, cultural, and linguistic topics.

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

*selected semesters*

Topics may include the following:

- Cultural Studies/Semiotics of Culture

### SPA 601 Latin American Feminist Cultural Production. (3)

*selected semesters*

Latin American feminist theory and studies as viewed through cultural production such as literature, film, photography, art. Seminar. Prerequisite: SPA 545 (or its equivalent).

### SPA 691 Figures and Works Seminar. (3)

*selected semesters*

Topics may be selected from Spanish and Spanish American literatures.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 50.

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## Law

### Doctoral and Certificate Programs

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

480/965-6181

LAW 201

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**Patricia D. White, Dean**

**Andrew Askland, Director**

**Center for the Study of Law, Science, and Technology**

**Catherine O'Grady, Executive Director,  
Clinical Programs**

**Jeffrie G. Murphy and James Nickel, Codirectors,  
Committee on Law and Philosophy**

**Kathlene Rosier, Director,  
Indian Legal Program**

**Judith M. Stinson, Director,  
Legal Research and Writing and Academic Success  
Programs**

**Regents' Professors:** Kaye, Murphy

**Professors:** Bartels, Bender, Berch, Brennan, Calleros, Clinton, Ellman, Feller, Fidel, Gorman, Gover, Grey, Guerin, Herrera, Jones, Kader, Karjala, Lowenthal, Lynk, Matheson, Nickel, O'Grady, Rose, Saks, Schatzki, Schroeder, Stanton, Strouse, Trotta, Tsosie, Tucker, Weinstein, M. White, P. White, Winer, Woodley

**Visiting Professor:** Spritzer

**Associate Professors:** Marchant, Noreuil, Sigler, Sylvester

**Clinical Professors:** Dallyn, Dauber

**Legal Writing Instructors:** Davis, Popko

**Senior Instructional Professional:** Stinson

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For more information, see "College of Law," page 73.

## LAW (LAW)

### LAW 500 Holding Registration. (1-16)

*fall and spring*

### LAW 515 Contracts I. (3)

*fall*

Explores common law legal method and the structure of Article 2 of the U.C.C. in the context of issues of contract formation.

### LAW 516 Criminal Law. (3)

*fall*

Substantive law of crimes.

### LAW 517 Torts I. (2-4)

*spring*

Legal protections of personality, property, and relational interests against physical, economic, and emotional harms.

### LAW 518 Civil Procedure I. (3)

*fall*

Explores the structure of a lawsuit and techniques of alternative dispute resolution. Specific topics include commencement of suit, joinder of parties, discovery, pretrial motions, and subject matter jurisdiction.

### LAW 519 Legal Method and Writing. (2)

*fall*

Examines methods used to analyze legal problems. Reviews precedent statutory construction and basic res judicata problems. Use of basic legal writing formats.

### LAW 520 Contracts II. (2)

*spring*

Continuation of LAW 515 focusing on contract interpretation.

### LAW 522 Constitutional Law I. (3)

*spring*

Role of courts in the federal system, distribution of powers between state and federal governments, and the role of procedure in litigation of constitutional questions.

### LAW 523 Property I. (2-3)

*fall*

Indicia of ownership, found property, estates in land, landlord tenant.

### LAW 524 Legal Research and Writing. (2)

*spring*

Continuation of LAW 519.

### LAW 525 Torts II. (2)

*spring*

Continuation of LAW 517 with emphasis on strict and products liability.

### LAW 526 Property II. (2-3)

*spring*

Nonpossessory interests in property (easements, covenants, servitudes); nuisance; land use planning; and transfers of interests in property.

### LAW 527 Civil Procedure II. (3)

*spring*

Continuation of LAW 518; subjects in LAW 518 are addressed in greater depth as well as personal jurisdiction, res judicata, collateral estoppel, and choice of law under the *Erie* doctrine.

### LAW 600 Administrative Law. (3)

*once a year*

Administrative process, emphasizing nature of powers exercised by administrative agencies of government, problems of procedure, and scope of judicial review.

### LAW 601 Antitrust Law. (3)

*once a year*

Legislation and its implementation to prevent monopoly and business practices in restraint of trade, including restrictive agreements involv-

ing price-fixing, trade association activities, and resale price maintenance.

**LAW 603 Conflict of Laws. (3)**

*selected semesters*

Problems arising when the operative facts of a case are connected with more than one state or nation. Choice of law, bases of jurisdiction, effect of foreign judgments, and underlying federal and constitutional issues.

**LAW 604 Criminal Procedure. (3)**

*fall and spring*

Nature of the criminal procedural system with special focus on constitutional protections for the accused.

**LAW 605 Evidence. (3)**

*once a year*

Principles and practice governing the competency of witnesses and presentation of evidence, including the rules of exclusion and roles of lawyer, judge, and jury under the adversary system.

**LAW 606 Federal Income Taxation. (3–4)**

*fall and spring*

Federal income tax in relation to concepts of income, property arrangement, business activity, and current tax problems, with focus on the process of tax legislation and administration.

**LAW 608 Business Associations I. (3)**

*once a year*

Partnerships, limited partnerships, and small business corporations. Includes a brief introduction to accounting. Detailed analysis of the problems of forming a close corporation, state law duties of care and loyalty, management, dividends and redemptions, issuance of stock, internal dispute resolution, dissolution, and the general law of derivative actions.

**LAW 609 Business Associations II. (3)**

*once a year*

Interrelationship of federal and state law and a brief introduction to corporate finance (1933 Act). Broad overview of large company regulations, including reporting rules, proxy regulation, insider trading, sale of control, tender offers and takeovers, and going private. Prerequisite: LAW 608.

**LAW 610 Advanced Criminal Procedure. (2–3)**

*once a year*

Topics in criminal procedure, with emphasis on legal constraints on grand jury investigations, police practices, pretrial release, preliminary hearings, prosecutorial discretion, and plea bargaining.

**LAW 611 Estate Planning. (2–3)**

*selected semesters*

Tax laws relating to transfer of wealth both at death and during lifetime, including federal estate tax, gift tax, and income taxation of estates and trusts.

**LAW 612 Family Law. (3)**

*once a year*

Legal and nonlegal problems that an individual may encounter because of a situation as a family member.

**LAW 613 Federal Courts. (3)**

*selected semesters*

Federal judicial system; relationship of federal and state law; jurisdiction of federal courts and their relation to state courts.

**LAW 615 Public International Law. (3)**

*once a year*

Role of law in international disputes. Considers drafting and interpretation of treaties and multilateral conventions.

**LAW 616 Jurisprudence. (3)**

*once a year*

Introduces legal philosophy, with readings on the nature of law and legal reasoning, the relationship between law and morality and equality and social justice.

**LAW 617 Genetics and the Law. (2–3)**

*once a year*

Provides background on genetics and recent genetic advances; addresses the legal consequences and issues associated with such advances.

**LAW 618 Trusts and Estates. (3)**

*once a year*

Substantive concepts involved in transmitting wealth, including interstate succession, wills and will substitutes, the modern trust as a

family protective device, creation of future interests in a planned estate, social restrictions of a nontax nature, and methods of devoting property to charitable purposes.

**LAW 619 Commercial Law: Payment and Credit Systems. (3)**

*fall*

Law of credit obligations and payment devices. Focuses on Articles 3, 4, and 4A of the Uniform Commercial Code.

**LAW 620 Civil Rights Legislation. (2–3)**

*selected semesters*

Coverage of the rights and remedies provided by federal civil rights legislation, principally, the key provisions of the Reconstruction Era Civil Rights Acts, portions of the employment discrimination legislation, and voting rights legislation.

**LAW 621 Commercial Law: Sales and Leases of Goods. (3)**

*spring*

Advanced issues involving the formation and interpretation of sales and lease contracts. Focuses primarily on Articles 2 and 2A of the Uniform Commercial Code.

**LAW 622 Commercial Law: Secured Transactions. (3)**

*once a year*

Secured transactions under Article 9 of the Uniform Commercial Code and other relevant sections. Overview of the creation, perfection, and priority effects of security interests. Financing of business enterprise and consumer credit.

**LAW 623 Commercial Torts. (3–4)**

*once a year*

Involves an analysis of actionable wrongs against a business entity or against proprietary rights held by that entity, covering the entire spectrum of private remedies for competitive wrongs.

**LAW 624 Community Property. (1–2)**

*fall and spring*

Property rights of husband and wife; the Arizona community property system; homestead.

**LAW 625 Constitutional Law II. (3–4)**

*fall, spring, summer*

Fundamental protection for person, property, political, and social rights.

**LAW 626 Law, Biology, and Human Behavior. (1–3)**

*once a year*

Considers whether recent advances in biology can usefully contribute to our understanding of behaviors that are relevant to law.

**LAW 627 Corporate Taxation. (2–3)**

*once a year*

Problems in taxability of the corporation, corporate distributions, and corporate reorganizations.

**LAW 628 Creditor-Debtor Relations. (3)**

*once a year*

Creditors' remedies in satisfaction of claims and debtors' protection and relief under bankruptcy, other laws.

**LAW 629 Employment Law. (3)**

*once a year*

Employment law topics, including testing, privacy, OSHA, FLSA, benefits, worker's compensation, rights to compensation, workplace emotional injuries, termination, and sexual harassment.

**LAW 630 Employment Discrimination. (2–3)**

*selected semesters*

Focuses primarily on Title VII of the Civil Rights Act of 1964, the Age Discrimination in Employment Act, and the Americans with Disabilities Act.

**LAW 631 Environmental Law. (3)**

*once a year*

Litigation, administrative law, and legislation relating to problems of environmental quality. Topics covered may include air and water pollution, toxic substances, pesticides, and radiation.

**LAW 632 Indian Law. (3)**

*once a year*

Inquiry into legal problems special to American Indians and tribes.

**LAW 633 Law, Litigation, and Science. (2–3)**

*once a year*

Fills a gap in the education of most lawyers, namely, how to effectively think about and use empirical evidence.



## GRADUATE PROGRAMS AND COURSES

### **LAW 635 Juvenile Justice System. (3)**

*selected semesters*

Special problems in the juvenile system.

### **LAW 636 Land Use Regulation. (2–3)**

*once a year*

Legal problems in the regulation and control of land development by state and local governments. Administration of zoning, subdivision, and other planning controls; issues of fairness and procedure in the utilization of such controls.

### **LAW 637 Lawyering Theory and Practice. (4)**

*fall and spring*

Issues of competency and professionalism in the practice of law.

### **LAW 638 Professional Responsibility. (3)**

*fall and spring*

Emphasizes the Model Rules and Model Code that govern the professional responsibility of lawyers and their interpretation and application.

### **LAW 639 Natural Resource Law. (3)**

*once a year*

Examines the constitutional basis for federal land management and the different kinds of public lands management schemes (e.g., parks, forests, wildlife refuges), emphasizing acquisition of right to, and regulation of, the different uses of public lands and resources (e.g., mining, grazing, timber, wildlife habitat, recreation).

### **LAW 640 Securities Regulation. (2)**

*once a year*

Selected problems arising under the major statutes concerned with regulating the securities market.

### **LAW 641 State and Local Government. (2–3)**

*selected semesters*

Legal problems involved in the organization and administration of governmental units, including the city, county, town, village, school district, and special district.

### **LAW 642 White Collar Crime. (2–3)**

*once a year*

Examines the ways in which "white collar" crime is prosecuted, principally in the federal system.

### **LAW 643 Water Law. (3)**

*once a year*

Acquisition of water rights; water use controls; interstate conflicts.

### **LAW 645 Patent Law. (3)**

*once a year*

In-depth examination of substantive patent law as it applies to the commercialization and enforcement of patent rights.

### **LAW 646 Copyright Law. (3)**

*once a year*

Legal rights in original forms of human expression.

### **LAW 647 Mass Tort Litigation. (2–3)**

*once a year*

Examines unique procedural and substantive issues that arise in mass tort litigation.

### **LAW 648 International Intellectual Property. (2–3)**

*once a year*

Considers patents, copyrights, and trademarks under international law and the major international treaties.

### **LAW 649 Scientific Evidence. (2–3)**

*once a year*

Examines the use of scientists and scientific tests or studies in criminal and civil litigation. Pre- or corequisite: LAW 605.

### **LAW 650 Health Law. (2–3)**

*once a year*

Introduction to health law.

### **LAW 651 Public Health Law. (2–3)**

*once a year*

Addresses the relationship between the state and the population's health.

### **LAW 701 Arbitration. (2–3)**

*once a year*

Examines the Federal Arbitration Act and the Uniform Arbitration Act as it has been adopted in Arizona.

### **LAW 702 Alternative Dispute Resolution. (2–3)**

*once a year*

Broad exposure to methods of settling disputes in our society such as mediation, arbitration/conciliation, and negotiation, including examination of the current litigation model.

### **LAW 703 Law, Science, and Technology. (2–3)**

*once a year*

Legal mechanisms used in dealing with various issues raised by contemporary science and technology. Explores current legal responses to science and technology.

### **LAW 705 Media Law. (2–3)**

*once a year*

Examines First Amendment principles and statutory and regulatory requirements with respect to the conventional print and broadcast media, as well as recent technologies such as cable.

### **LAW 706 Immigration Law. (2–3)**

*selected semesters*

Explores political, economic, social, and legal issues concerning immigration. Specific topics covered include citizenship and naturalization, denaturalization, deportation, and refugee rights and asylum.

### **LAW 707 Elder Law. (2–3)**

*once a year*

Looks at legal and policy questions related to aging individuals and an older society. Seminar.

### **LAW 708 Gender, Sexuality, and the Law. (2–3)**

*once a year*

Examines assumptions made in the law about gender and sexuality and the impact of those assumptions on the application of the law. Seminar.

### **LAW 709 International Human Rights. (2–3)**

*selected semesters*

International rules and procedures governing the protection of human rights.

### **LAW 710 Real Estate Tax Planning. (2–3)**

*once a year*

Discusses topics, including but not limited to real estate investments as tax shelters, alternative acquisition finance devices, refinancing techniques, and nontaxable exchanges.

### **LAW 712 Religion and the Constitution. (2–3)**

*once a year*

In-depth study of the "establishment" and "free exercise" clauses of the First Amendment to the U.S. Constitution.

### **LAW 715 Professional Sports. (2–3)**

*selected semesters*

Unique legal problems relating to professional sports, including their relationship to antitrust laws, the nature of player contracts, and associated tax problems.

### **LAW 721 Education and the Law. (2–3)**

*selected semesters*

Current legal problems affecting institutions of higher education, faculty, students, and governing boards.

### **LAW 722 Mexican Law. (2–3)**

*fall*

Comparative overview of Mexican law. Poses questions regarding the proper role and function of a legal system. Seminar.

### **LAW 733 Negotiation, Mediation, and Counseling. (3)**

*once a year*

Explores alternative models of negotiated dispute resolution, as well as the roles of lawyer and client in the negotiation process. Extensive use of simulation exercises.

### **LAW 734 Products Liability. (2–3)**

*once a year*

Traces the development of products liability law; analyzes the major issues currently confronting the courts in this area. Seminar.

### **LAW 738 Trial Advocacy. (2–3)**

*fall and spring*

Confronts issues of trial advocacy through simulation of a variety of aspects of trial practice in a mock court setting. Prerequisite: LAW 605.

**LAW 745 The Supreme Court. (2–3)**

*once a year*

Intensive examination of selected current decisions of the U.S. Supreme Court.

**LAW 768 International Business Transactions. (2–3)**

*selected semesters*

Problems and policy considerations involved in international trade; tariffs, international monetary controls, and development loans.

**LAW 770 Law Journal. (1–3)**

*fall and spring*

Academic credit for successful completion of editorial work by a member of the staff of *Arizona State Law Journal*. May be repeated for credit for a maximum of 5 semester hours.

**LAW 771 Jurimetrics Journal. (1–3)**

*fall and spring*

Academic credit for successful completion of editorial work by a member of the staff of the *Jurimetrics Journal of Law, Science, and Technology*. Studio.

**LAW 772 Public Defender Clinic. (1–6)**

*fall, spring, summer*

Placement in the Public Defender Clinic and related classroom component. Prerequisite: LAW 605.

**LAW 773 Civil Practice Clinic. (1–6)**

*fall, spring, summer*

Placement in the Civil Practice Clinic and related classroom component. Prerequisite: LAW 605.

**LAW 774 Criminal Practice Clinic. (1–6)**

*fall, spring, summer*

Placement with various prosecutor offices in the Phoenix area and related classroom component. Prerequisite: LAW 605.

**LAW 775 Mediation Clinic. (1–4)**

*fall and spring*

Study of the mediation process and experience as mediators in cases pending before the justice courts and administrative agencies.

**LAW 780 Moot Court. (1–3)**

*fall and spring*

Academic credit for successful completion of work as a member of the Moot Court Board of Directors; maximum of 3 semester hours.

**LAW 781 Individual Study. (1)**

*fall, spring, summer*

With the approval of a faculty member, a student may research a legal subject of special interest and prepare a paper suitable for publication.

**LAW 782 Individual Study. (2)**

*fall, spring, summer*

See LAW 781.

**LAW 783 Individual Study. (3)**

*fall, spring, summer*

See LAW 781.

**LAW 784 Moot Court Competition. (1–4)**

*fall and spring*

Successful participation and completion of a national moot court competition.

**LAW 785 Externship. (1–12)**

*fall, spring, summer*

Supervised, practical lawyering in an external placement proposed by the student or established by a sponsoring agency and approved by the College of Law. In addition, an associated academic component is established by the student with a member of the faculty.

**LAW 791 Seminar in Law. (1–12)**

*fall and spring*

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 50.

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## Law, Science, and Technology

### Certificate Program

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The Certificate in Law, Science, and Technology is available only to students in the College of Law. For more information, see "College of Law," page 73.

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## Linguistics

### Certificate Program

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For information on the Graduate Certificate in Linguistics, access the Web site at [linguistics.asu.edu](http://linguistics.asu.edu), or call 480/965-0792. For LIN courses, see "Linguistics (LIN)," page 212.

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## Mass Communication

### Master's Program

[cronkite.asu.edu/graduate.html](http://cronkite.asu.edu/graduate.html)

480/965-5011

STAUF A231B

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**Stephen K. Doig, Interim Director**

**Professors:** Craft, Cronkite, Doig, Foote, Godfrey, Goldstein, Merrill, Sylvester, Watson

**Associate Professors:** Allen, Barrett, Bramlett-Solomon, Galician, Matera, Russell, Russomanno

**Assistant Professors:** Gavrilos, Keith, Schwalbe, Silcock

**Clinical Professors:** Itule, Leigh

**Lecturers:** Casavantes, Nichols

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### MASTER OF MASS COMMUNICATION

The faculty in the Walter Cronkite School of Journalism and Mass Communication offer a graduate program leading to the academic and professional degree Master of Mass Communication (M.M.C.). The program is designed to help students achieve academic and professional growth, to prepare students for positions in the mass media, and to provide a background to enable persons currently in the media to advance their careers.

**Admission.** In addition to the general requirements for admission to the Graduate College, the M.M.C. program

## GRADUATE PROGRAMS AND COURSES

requires applicants to provide three letters of recommendation (including two from professors in the last unit of study from degree-granting institutions), scores on either the GRE (verbal and quantitative) or the MAT, a biographical sketch or résumé that includes all professional media experience, and a 250 to 500 word statement outlining career aspirations that could be enhanced by admission to the program (the statement is also used as a writing sample). The applicant's undergraduate GPA, letters of recommendation, test scores, and professional media experience are all considered in the admission process. A TOEFL score of 600 or higher is required of all applicants whose native language is not English. Applicants wishing to enroll for fall semester must have all their application materials submitted by February 1.

**Admission Classification.** Applicants who have an undergraduate degree in an area of mass communication, who meet all other requirements, and who receive regular admission may begin the 30 or 36 semester hour programs in the fall. A two-year program is designed for applicants who have an undergraduate degree in a discipline other than mass communication. This program consists of 45 semester hours. The first-year courses are designed to provide a foundation in journalism knowledge and skills. Some first-semester courses are prerequisites for courses to be taken in subsequent semesters.

**Registration.** Registration in 500-level courses is limited to students who have been admitted to the M.M.C. program or have approval from the instructor of the class. Nondegree graduate students may not register for 500-level courses in the Walter Cronkite School of Journalism and Mass Communication during early registration. Undergraduate students wishing to reserve graduate course credit must follow Graduate College guidelines and obtain approval from the director of graduate studies.

**Programs of Study.** The Walter Cronkite School of Journalism and Mass Communication offers three programs of study leading to the M.M.C. degree.

The 45-semester-hour program is for students with undergraduate degrees in areas other than mass communication. Requirements are as follows:

1. 15 semester hours of core course work,
2. 12 hours of specialization courses,
3. six hours of mass communication skills courses,
4. nine hours of related courses outside the school, and
5. three hours of supervised applied project (MCO 593) credit.

The 36-semester-hour program is for students with undergraduate degrees in areas of mass communication. Requirements are as follows:

1. 12 semester hours of core course work,
2. six to 12 hours of specialization courses,
3. nine to 15 hours of related courses outside the school, and
4. three hours of supervised applied project (MCO 593) credit.

The 30-semester-hour program is for students with undergraduate degrees or significant professional experience in areas of mass communication and who choose to write a thesis. Requirements are as follows:

1. 15 semester hours of core course work,
2. nine hours of a related area outside the school, and
3. six hours of directed thesis (MCO 599).

**Foreign Language Requirements.** None.

**Thesis Requirements.** For the 30-semester-hour program only.

**Final Examination.** An oral examination in defense of the supervised research or creative project is required.

### JOURNALISM AND MASS COMMUNICATION (JMC)

#### **JMC 401 Advanced Public Relations. (3)**

*fall and spring*

Advanced theory and practice of publicity, public relations, and related techniques and procedures. Prerequisites for undergraduates: JMC 270; JMC professional status.

#### **JMC 412 Editorial Interpretation. (3)**

*selected semesters*

The press as an influence on public opinion. Role of the editorial in analyzing and interpreting current events. Prerequisites for undergraduates: JMC 301; JMC professional status.

#### **JMC 413 Advanced Editing. (3)**

*fall and spring*

Theory and practice of newspaper editing, layout and design, picture and story selection. Fee. Prerequisites for undergraduates: JMC 313; JMC professional status.

#### **JMC 414 Electronic Publication Design. (3)**

*fall and spring*

Theory, organization, and practice of layout, typography, and design in traditional and multimedia publishing. Fee. Prerequisites for undergraduates: JMC 270; JMC professional status.

#### **JMC 415 Writing for Public Relations. (3)**

*fall and spring*

Development of specific writing techniques for the practitioner in public relations agencies and divisions of major organizations. Fee. Prerequisites for undergraduates: JMC 270; JMC professional status.

#### **JMC 417 Public Relations Campaigns. (3)**

*fall and spring*

Theory, principles, and literature of public relations and how they relate to audiences, campaigns, and ethics. Prerequisite: JMC 401. Prerequisite for undergraduates: JMC professional status.

#### **JMC 420 Reporting Public Affairs. (3)**

*fall and spring*

Instruction and assignments in reporting the courts, schools, government, city hall, social problems, and other areas involving public issues. Prerequisites for undergraduates: JMC 301; JMC professional status.

#### **JMC 425 Online Media. (3)**

*fall and spring*

Focuses on the Internet from the perspective of the journalist—the best way to tell a story using words, photos, video, and audio. Lecture, lab. Fee. Prerequisites: JMC 201 (or its equivalent); JMC professional status.

#### **JMC 433 Media Sales and Promotion. (3)**

*fall and spring*

Basics of electronic media marketing practices, including commercial time sales techniques and radio/TV promotion fundamentals. Prerequisites for undergraduates: JMC 200; JMC professional status.

#### **JMC 437 Documentary Production. (3)**

*fall and spring*

Emphasizes individual production projects of the student's own conception and design utilizing studio, field, and postproduction techniques. Prerequisites for undergraduates: JMC 235; JMC professional status.

**JMC 440 Magazine Writing. (3)**

*fall and spring*

Writing and marketing magazine articles for publication. Prerequisites for undergraduates: JMC 301; JMC professional status.

**JMC 445 Science Writing. (3)**

*once a year*

Develops writing, interviewing, reporting skills, and an understanding of key concepts in science. Lecture, lab. Fee. Prerequisites: student in B.A. in Journalism and Mass Communication or M.M.C. in Mass Communication; instructor approval.

**JMC 451 Photojournalism II. (3)**

*fall and spring*

Emphasizes shooting and Photoshop skills for newspaper and magazine assignments. Film and digital photography, flash and studio lighting. Fee. Prerequisite: JMC 351. Prerequisite for undergraduates: JMC professional status.

**JMC 452 Photojournalism III. (3)**

*fall and spring*

Continued practice in shooting (film and digital) and Photoshop skills for newspapers and magazines. Emphasizes single images, picture stories, editorial illustrations, and portfolio development. 2 hours lecture, 2 hours lab. Fee. Prerequisite: JMC 451. Prerequisite for undergraduates: JMC professional status.

**JMC 465 Precision Journalism. (3)**

*fall and spring*

Advanced reporting methods using Internet research and data analysis tools for beat and investigative stories. Lecture, lab. Fee. Prerequisites for undergraduates: JMC 301; JMC professional status.

**JMC 470 Depth Reporting. (3)**

*fall and spring*

Introduces strategies for writing in-depth newspaper or magazine articles. Lecture, lab. Fee. Prerequisites for undergraduates: JMC 301; JMC professional status; instructor approval.

**JMC 472 Media Management. (3)**

*fall, spring, summer*

Management principles and practices, including organization, procedures, policies, personnel problems, and financial aspects of station management. Pre- or corequisites for undergraduates: JMC 332; JMC professional status.

**JMC 475 Television Newscast Production. (3)**

*fall and spring*

Writing, reporting, and production of the television newscast. Prerequisite: instructor approval. Prerequisite for undergraduates: JMC professional status.

**JMC 494 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 50.

**MASS COMMUNICATION (MCO)**

**MCO 418 History of Mass Communication. (3)**

*fall and spring*

American journalism from its English and colonial origins to the present day. Development and influence of newspapers, magazines, radio, television, and news gathering agencies.

**MCO 421 Media Problems. (3)**

*fall and spring*

Trends and problems of the mass media, emphasizing editorial decisions in the processing of information. Prerequisite: professional status.

**MCO 430 International Mass Communication. (3)**

*fall and spring*

Comparative study of communication and media systems. Information gathering and dissemination under different political and cultural systems.

**MCO 435 Emerging Media Technologies. (3)**

*once a year*

Surveys new telecommunication technologies in a convergent environment.

**MCO 440 Applied Media Research. (3)**

*fall and spring*

Design, conduct, and analysis of applied media research. Students participate in the Cactus State Poll. Lab setting. Prerequisite: professional status.

**MCO 450 Visual Communication. (3)**

*fall, spring, summer*

Theory and tradition of communication through the visual media with emphasis on the continuity of traditions common to modern visual media.

**MCO 456 Political Communication. (3)**

*fall and spring*

Theory and research related to political campaign communication. The persuasive process of political campaigning, the role of the media, the candidate, and image creation.

**MCO 460 Race, Gender, and Media. (3)**

*spring and summer*

Reading seminar designed to give a probing examination of the interface between AHANA Americans and the mass media in the United States. Lecture, discussion. Cross-listed as AFR 460. Credit is allowed for only AFR 460 or MCO 460.

**MCO 473 Sex, Love, and Romance in the Mass Media. (3)**

*fall and spring*

The role of the mass media in constructing and/or reinforcing unrealistic mythic and stereotypic images of sex, love, and romance. Lecture, discussion. Prerequisites for nonmajors: 24 hours; 2.00 GPA. Prerequisites for majors: 40 hours; 2.50 GPA.

**MCO 501 Newswriting and Reporting. (3)**

*fall*

Designed for graduate students in the M.M.C. program who have undergraduate degrees in nonjournalism areas. Objective is to teach fundamentals of writing and reporting. Lecture, lab. Fee. Prerequisite: acceptance into M.M.C. graduate program or instructor approval.

**MCO 503 Press Freedom Theory. (3)**

*fall*

Examines philosophical and legal aspects of press freedom. Emphasizes First Amendment theory evolution from 1791 to present.

**MCO 510 Research Methodology in Mass Communication. (3)**

*fall*

Identifies research problems in mass communication. Overview of questionnaire construction. Attention to survey, historical, content analysis, experimental, and legal research methods. Prerequisite: acceptance into M.M.C. graduate program or instructor approval.

**MCO 520 Mass Communication Theories and Process. (3)**

*fall*

Analyzes various theoretic models of mass communication with emphasis on the applications of these theories to various professional communication needs.

**MCO 522 Mass Media and Society. (3)**

*spring*

Mass media as social institutions, particularly interaction with government and public. Emphasizes criticism and normative statements.

**MCO 530 Media Ethics. (3)**

*fall*

Ethical conventions and practices of print and electronic media as they relate to the government and private sectors of society.

**MCO 531 Broadcast Journalism. (3)**

*spring*

News and information practices of networks, stations, and industry. Practice in writing, reporting, and editing with emphasis on video. Lecture, lab. Prerequisite: MCO 501.

**MCO 540 Historical/Legal Methods. (3)**

*spring*

Introduces legal and historical methods necessary to conduct qualitative mass communication research. Prerequisite: M.M.C. graduate student.

**MCO 560 Arizona Media Law. (3)**

*fall*

Case study approach to first amendment issues, media access, libel, confidentiality, and invasion of privacy as applied to media organizations in Arizona. Lecture, seminar.

## GRADUATE PROGRAMS AND COURSES

**MCO 593 Applied Project. (3)**  
*fall and spring*

**MCO 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 50.

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### Materials Engineering

#### Master's and Doctoral Programs

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

480/965-3313

ECG 202

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Subhash Mahajan, Chair

**Regents' Professor:** Mayer

**Professors:** Adams, Alford, Dey, Krause, Mahajan, Newman, Picraux, Sieradzki

**Associate Professors:** Chawla, Van Schilfhaarde

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The faculty in the Department of Chemical and Materials Engineering offer graduate programs leading to the Master of Science (M.S.) degree, the Master of Science in Engineering (M.S.E.) degree, and the Ph.D. degree in Engineering Science with specializations in materials science and engineering (see "Engineering Science," page 206, for program description). Areas of concentration include electronic and advanced materials processing, mechanical behavior of materials, composites, thin films, ceramics, characterization and simulation of materials, and biomaterials.

A *Graduate Student Handbook*, detailing information on studies in the Master's and Doctoral programs, is available to admitted students. For information on graduate studies in Materials Engineering, access the Web site at [www.eas.asu.edu/~cme](http://www.eas.asu.edu/~cme), or call the Department of Chemical and Materials Engineering at 480/965-3313.

The faculty also participate in offering the interdisciplinary program leading to the Ph.D. degree with a major in Science and Engineering of Materials (see "Science and Engineering of Materials," page 320, for program description).

**Graduate Record Examination.** Graduate Record Examination scores are required from all applicants.

#### MASTER OF SCIENCE

For more information, including general requirements, see "Master's Degrees," page 94.

**Transition Program.** Students applying for the program leading to a master's degree with a major in Materials Engineering may have an undergraduate B.S. degree in a major field other than Materials Engineering or Materials Science. The qualifications of transition students are reviewed by the department graduate committee and a special program is

then designed for successful applicants. In general applicants should have had, or should be prepared to take, calculus through differential equations, chemistry, and physics. Transition students are expected to complete the essential courses in their area of study from the undergraduate program in order to be prepared for the graduate courses. Other course work from the undergraduate program may be required depending upon the area of study selected by the student. Transition students should contact the graduate coordinator for an evaluation of their undergraduate transcript.

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

**Thesis Requirements.** A thesis or equivalent is required for the M.S. degree.

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

#### MASTER OF SCIENCE IN ENGINEERING

See "Master of Science in Engineering," page 204, for program description.

#### DOCTOR OF PHILOSOPHY

The Ph.D. degree in the area of study in materials science and engineering under the Engineering Science major, is conferred upon evidence of excellence in research resulting in a scholarly dissertation that is a contribution to existing knowledge. See "Doctor of Philosophy," page 96, for general requirements.

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

**Foreign Language Requirements.** Candidates in the program leading to the Ph.D. degree in the area of study in materials science and engineering, under the Engineering Science major, normally are not required to pass an examination showing reading competency of a foreign language. However, the supervisory committee may establish such a

requirement in special cases depending upon the research interests of the candidate. If a foreign language is required, the student must successfully fulfill the requirement before taking the comprehensive examination.

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

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

## RESEARCH ACTIVITY

The research thrusts in Materials Engineering are:

1. growth, processing, and characterization of electronic materials;
2. electroceramics;
3. deformation behavior of materials at different length scales;
4. computational materials science; and
5. nanoscience and nanotechnology.

Some of the research projects that are currently being pursued are:

1. growth of group III nitrides by organometallic vapor phase epitaxy and molecular beam epitaxy and their fabrication into high frequency, high power, and high temperature devices;
2. fabrication of spintronic devices for very high frequency applications;
3. synthesis of high k dielectric films by organometallic vapor phase epitaxy and correlation of properties with microstructures;
4. process-induced defects in implantation and annealing of GaN;
5. creep and thermal fatigue behaviors of lead-free solder balls used in electronic packaging;
6. modeling of the evolution of thin film microstructures; and
7. synthesis and characterization of quantum dots.

For more information, access the Web site at [www.eas.asu.edu/~cme](http://www.eas.asu.edu/~cme).

## MATERIALS SCIENCE AND ENGINEERING (MSE)

### MSE 510 X-Ray and Electron Diffraction. (3)

*spring*

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

### MSE 511 Corrosion and Corrosion Control. (3)

*spring in odd years*

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

### MSE 512 Analysis of Material Failures. (3)

*spring in even years*

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

### MSE 513 Polymers and Composites. (3)

*fall*

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

### MSE 514 Physical Metallurgy. (3)

*spring*

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

### MSE 515 Thermodynamics of Materials. (3)

*spring*

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

### MSE 516 Mechanical Properties of Solids. (3)

*fall*

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

### MSE 517 Introduction to Ceramics. (3)

*fall*

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

### MSE 520 Theory of Crystalline Solids. (3)

*selected semesters*

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

### MSE 521 Defects in Crystalline Solids. (3)

*spring*

Introduces the geometry, interaction, and equilibrium between dislocations and point defects. Discusses relations between defects and properties. Prerequisite: ECE 350 or instructor approval.

### MSE 530 Materials Thermodynamics and Kinetics. (3)

*spring*

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

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

*spring in odd years*

Relationship between microstructure and fracture; fatigue and creep properties of materials. Environmental effects and recent developments. Current theories and experimental results. Prerequisite: MSE 440 (or its equivalent).

### MSE 550 Advanced Materials Characterization. (3)

*fall*

Analytical instrumentation for characterization of materials; SEM, SIMS, Auger, analytical TEM, and other advanced research techniques.

### MSE 552 Electron Microscopy I. (3)

*fall*

Kinematical and dynamical electron diffraction and microscopy. Defect structure and composition using STEM imaging, x-ray and electron-energy-loss spectroscopy. Cross-listed as PHY 552/SEM 552. Credit is allowed for only MSE 552 or PHY 552 or SEM 552. Prerequisite: instructor approval.

### MSE 553 Electron Microscopy Laboratory I. (3)

*fall*

Lab support for MSE 552. Cross-listed as PHY 553/SEM 553. Credit is allowed for only MSE 553 or PHY 553 or SEM 553. Pre- or corequisite: MSE 552 or PHY 552 or SEM 552.

### MSE 554 Electron Microscopy II. (3)

*spring*

Determination of structure and composition of materials using high-resolution imaging, convergent-beam diffraction, and electron holography. Novel developments and applications. Cross-listed as PHY 554/SEM 554. Credit is allowed for only MSE 554 or PHY 554 or SEM 554. Prerequisite: instructor approval.

## GRADUATE PROGRAMS AND COURSES

### **MSE 555 Electron Microscopy Laboratory II. (3)**

*spring*

Lab support for MSE 554. Cross-listed as PHY 555/SEM 555. Credit is allowed for only MSE 555 or PHY 555 or SEM 555. Pre- or corequisite: MSE 554 or PHY 554 or SEM 554.

### **MSE 560 Strengthening Mechanisms. (3)**

*selected semesters*

Deformation of crystalline materials. Properties of dislocations. Theories of strain hardening, solid solution, precipitation, and transformation strengthening. Prerequisite: ECE 350 (or its equivalent).

### **MSE 561 Phase Transformation in Solids. (3)**

*spring in even years*

Heterogeneous and homogeneous precipitation reactions, shear displacive reactions, and order-disorder transformation.

### **MSE 562 Ion Implantation. (3)**

*selected semesters*

Includes defect production and annealing. Generalized treatment, including ion implantation, neutron irradiation damage, and the interaction of other incident beams. Prerequisite: MSE 450.

### **MSE 570 Polymer Structure and Properties. (3)**

*spring in even years*

Relationships between structure and properties of synthetic polymers, including glass transition, molecular relaxations, crystalline state viscoelasticity, morphological characterization, and processing.

### **MSE 571 Ceramics. (3)**

*selected semesters*

Includes ceramic processing, casting, molding, firing, sintering, crystal defects, and mechanical, electronic, and physical properties. Prerequisites: MSE 521, 561.

### **MSE 573 Magnetic Materials. (3)**

*selected semesters*

Emphasizes ferromagnetic and ferrimagnetic phenomena. Domains, magnetic anisotropy, and magnetostriction. Study of commercial magnetic materials. Prerequisite: MSE 520 (or its equivalent).

### **MSE 598 Special Topics. (1–4)**

*selected semesters*

Topics may include the following:

- Composite Materials. (3)
- Computer Simulation in Materials Science. (3)
- Contemporary Issues in Semiconductor Processing and Manufacturing. (3)
- Electronic Thin Films. (3)
- Growth and Processing of Semiconductors. (3)
- Growth and Processing of Semiconductors Laboratory. (1)
- Nanomaterials: Synthesis and Evaluation. (3)
- Vacuum Systems Science and Engineering. (3)

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 50.

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## Materials Science

### Interdisciplinary Master's Program

[www.asu.edu/graduate/SEM](http://www.asu.edu/graduate/SEM)

480/965-2460

PS A323

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**James B. Adams, Codirector**

**William T. Petuskey, Codirector**

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

Professors: Adams, Alford, Dey, Krause, Mahajan, Newman, Picraux

#### **Chemistry and Biochemistry**

Regents' Professor: Buseck  
Professors: Kouvetakis, Petuskey  
Assistant Professor: Matyushov

#### **Electrical Engineering**

Regents' Professor: Ferry  
Professors: Goodnick, Kozicki, Schroder, Thornton, Zhang

#### **Mechanical and Aerospace Engineering**

Professor: Sieradzki

#### **Physics and Astronomy**

Regents' Professor: Smith  
Professors: Bennett, Ponce, Rez, Sankey, Tsong, Venables  
Associate Professors: Culbertson, Drucker, Herbots, Marzke

#### **Solid State Science**

Professor: Carpenter  
Senior Research Scientists: Crozier, McCartney, McKelvy  
Associate Research Scientist: Sharma

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The Science and Engineering of Materials Program offers an interdisciplinary master's degree in Materials Science. The members of the faculty are from several academic and research units in the College of Liberal Arts and Sciences and the Ira A. Fulton School of Engineering: the Departments of Chemical and Materials Engineering, Chemistry and Biochemistry, Electrical Engineering, Mechanical and Aerospace Engineering, and Physics and Astronomy, and the Center for Solid State Science.

#### **MATERIALS SCIENCE—M.S.**

The M.S. degree in Materials Science is an interdisciplinary program of study that integrates courses offered by several academic departments and faculty representing various disciplines to provide a sound foundation for research leading to a thesis. Emphasis is placed on application of the core fundamentals for investigation of the relationships between syntheses, microstructure, physical and chemical properties, and the performance of solids in current technological applications.

**Admission.** All applications for graduate study are processed by the ASU Graduate College. An online application is on the Web at [www.asu.edu/graduate](http://www.asu.edu/graduate). Applicants must satisfy Graduate College requirements, which include

1. application;
2. application fee of \$45;
3. official transcripts;
4. official TOEFL for international students (minimum of 600 for admission to the SEM Program); and
5. TSE for students who wish to be considered for a teaching assistantship.

Students must also satisfy the requirements of the program:

1. GRE (verbal, quantitative and analytical);
2. résumé;
3. statement of purpose; and
4. three letters of recommendation.

All application materials must be received by the program (postmarked) by February 15 for the fall semester and October 15 for the spring semester.

**Program of Study.** The master’s degree is structured around a comprehensive set of courses contained in the participating disciplines. Because of the multidisciplinary emphasis of the program, a balance is sought of courses that are taught with engineering and science objectives. The program consists of 33 semester hours beyond the bachelor’s degree. A minimum of 24 semester hours are split evenly between four core courses (12 semester hours) and four elective courses (12 semester hours). The remaining semester hours are devoted to seminar, research, and thesis (three semester hours each).

**Interdisciplinary Course Hours**

CHM 471 Solid-State Chemistry .....	3
CHM 541 Advanced Thermodynamics .....	3
or MSE 530 Materials Thermodynamics and Kinetics (3)	
PHY 481 Materials Physics I.....	3
SEM 500 Research Methods.....	3
SEM 591 Graduate Seminar.....	3
Total .....	15

**Foreign Language Requirements.** None.

**Thesis Requirements.** The thesis, which is the final and most important product of the student’s effort in this program, must report original research in the field and demonstrate the student’s ability to conduct creative, independent research. Each candidate must register for three semester hours of research and three semester hours of thesis.

**Final Examination.** The final examination in defense of the thesis is conducted by the student’s thesis committee and other faculty members appointed by the dean of graduate studies.

**COURSES**

For courses, see “*Science and Engineering of Materials (SEM)*,” page 321.

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**Mathematics**

**Master’s and Doctoral Programs**

[math.la.asu.edu](http://math.la.asu.edu)

480/965-3951

PS A216

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**Andrew Bremner, Chair**

**Professors:** Armbruster, Bremner, Castillo-Chavez, Gardner, Hoppensteadt, Ihrig, Jackiewicz, Kadell, Kawski, Kierstead, Kostelich, Kuang, Kuiper, Lai, Lohr, Lopez, Mahalov, Mittelmann, Nicolaenko, Quigg, Renaut, Ringhofer, Smith, Thieme, Young

**Associate Professors:** Baer, Barcelo, Blount, Carlson, Childress, Farmer, Gelb, Hurlbert, D. Jones, J. Jones, McCarter, Moore, Nikitin, Prewitt, Spielberg, Suslov, Taylor, Welfert

**Assistant Professors:** Czygrinow, Kaliszewski, Oehrtman, Oleson, Zandieh

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

The faculty also participate in the program leading to the Master of Natural Science (M.N.S.) degree when one of the concentrations is mathematics. In collaboration with the College of Education, the Department of Mathematics and Statistics offers an option for the M.N.S. degree that leads to high school certification.

In addition, the faculty participate in the interdisciplinary program leading to the M.S. degree in Statistics (see “Statistics,” page 335).

It is required that students applying to one of these programs submit scores on the Graduate Record Examination.

Students in the College of Education admitted to the Master of Education (see “Master of Education,” page 189) or Doctor of Education (see “Doctor of Education,” page 190) degree program in Secondary Education may elect mathematics as the subject matter field. These programs are offered through the College of Education.

**MASTER OF ARTS**

This degree is designed for students who wish to extend their knowledge of mathematics or prepare for certain careers related to mathematics. To be admitted without deficiencies, the student’s background should include an undergraduate mathematics major or an equivalent preparation such as may be obtained in certain undergraduate programs in engineering or the sciences. In particular, the student’s preparation must include courses in linear algebra and foundations of analysis. A certain degree of familiarity with computer languages may also be required for some areas of study.



## GRADUATE PROGRAMS AND COURSES

Students pursuing the M.A. degree in Mathematics may choose one of the following areas: general mathematics, applied mathematics, statistics and probability, mathematics education, and computational mathematics. Information concerning the requirements for each area may be obtained from the department.

See “Master’s Degrees,” page 94, for general requirements.

**Program of Study.** The program of study, including courses in mathematics and related subjects, is selected with the recommendation of the student’s supervisory committee. Ordinarily, a program of study consists of a minimum of 30 semester hours.

**Foreign Language Requirements.** None.

**Thesis Requirements.** Students can choose a thesis or a nonthesis M.A. degree. For details, contact the department.

**Comprehensive Examinations.** Written examinations are required for both thesis and nonthesis options—one for the thesis option and two for the nonthesis option. For the thesis option, course work can be substituted for the exam. For more information, contact the department.

**Final Examination.** For students who choose the thesis option, a final oral examination in defense of the thesis is required.

### MASTER OF NATURAL SCIENCE

The faculty of the Department of Mathematics and Statistics participate in programs leading to the M.N.S. degree (see “Natural Science,” page 287). This degree is intended for the student who is interested in an interdisciplinary program with a major emphasis in mathematics and a minor emphasis in a related subject outside mathematics. The student’s supervisory committee consists of two faculty members of the department and one faculty member of the department in the related area. The supervisory committee designs a program of study of at least 36 semester hours that is appropriate for the type of interdisciplinary work the student wishes to pursue. One option of the M.N.S. degree leads to high school certification and another focuses on mathematics education. The intention is to develop high school teachers with an excellent subject knowledge in mathematics. For more information, contact the Department of Mathematics and Statistics.

### DOCTOR OF PHILOSOPHY

This Ph.D. is intended for the student with superior mathematical ability, emphasizing the development of creative scholarship and breadth and depth in background knowledge. Admission to the degree program is normally granted after completion of the master’s degree. See “Doctoral Degrees,” page 96, for general requirements.

**Program of Study.** The program of study is selected with the recommendation of the student’s supervisory committee.

**Qualifying Examinations.** Qualifying examinations are required. They test a student’s mastery of basic material in

two of the following five areas: algebra, differential equations, mathematical statistics, numerical methods, and real analysis. Normally, students entering the graduate program with a bachelor’s degree take these qualifying examinations at the beginning of the third semester, and those entering with a master’s degree at the beginning of the second semester. These examinations are given once each semester.

**Foreign Language Requirements.** None.

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

**Dissertation Requirements.** A dissertation reporting significant, original research suitable for publication in a professional research journal is required. (See “Doctoral Dissertations,” page 96.)

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

### RESEARCH ACTIVITY

With 49 faculty members in the Department of Mathematics and Statistics, research interests cover most aspects of mathematics. In particular, the department has strengths in algebra, analysis, computational mathematics, control and system science, differential equations, discrete mathematics, dynamical systems and chaos, mathematical biology, mathematics education, number theory, and statistics. Research interests of the faculty may be seen by accessing the department’s Web site at [math.la.asu.edu](http://math.la.asu.edu).

### MATHEMATICS (MAT)

#### **MAT 410 Introduction to General Topology. (3)**

*once a year*

Topological spaces, metric spaces, compactness, connectedness, and product spaces. Prerequisite: MAT 300 or 371 or instructor approval.

#### **MAT 415 Introduction to Combinatorics. (3)**

*fall*

Topics include proof techniques, permutations, combinations; counting techniques, including recurrence relations, generating functions, inclusion-exclusion; Ramsey theory and combinatorial designs. Prerequisites: both MAT 300 (or 243) and 342 (or 242 or 343) or only instructor approval.

#### **MAT 416 Introduction to Graph Theory. (3)**

*spring*

Topics include trees, cycles, matchings, planarity, connectivity, hamiltonicity, colorings, graph algorithms, and other advanced topics. Prerequisites: both MAT 300 (or 243) and 342 (or 242 or 343) or only instructor approval.

#### **MAT 419 Introduction to Linear Programming. (3)**

*spring*

Simplex method, duality, and network flows. Applications to game theory, geometry, combinatorics, graph theory, and posets. Prerequisites: a combination of CSE 100 (or 200 or 210) and MAT 300 (or 243) and 342 (or 242 or 343) or only instructor approval.

#### **MAT 420 Scientific Computing. (3)**

*fall*

Surveys and applies programming languages, libraries, and scientific visualization tools. Programming assignments emphasize software development skills. Lecture, lab. Fee. Prerequisites: a combination of CSE 200 and MAT 274 (or 275) and 342 (or 343) (or their equivalents) or only instructor approval.

#### **MAT 421 Applied Computational Methods. (3)**

*fall and spring*

Numerical methods for quadrature, differential equations, roots of nonlinear equations, interpolation, approximation, linear equations, float-

ing-point arithmetic, and roundoff error. Prerequisites: both MAT 271 (or its equivalent) and fluency in computer programming (preferably FORTRAN) or only instructor approval.

**MAT 423 Numerical Analysis I. (3)**

*fall*

Analysis and algorithms for numerical solutions linear/nonlinear equations, direct solvers, iterative procedures, optimization. Determination of eigenvalues. Elementary computer arithmetic. Prerequisites: both MAT 342 (or 343) and fluency in computer programming or only instructor approval.

**MAT 425 Numerical Analysis II. (3)**

*spring*

Analysis of and algorithms for numerical interpolation, integration, and differentiation. Numerical solution of ordinary differential equations, and method of lines. Those seeking a methods survey course should take MAT 421. Prerequisites: both MAT 274 (or 275) and fluency in computer programming or only instructor approval. MAT 371 recommended.

**MAT 427 Computer Arithmetic. (3)**

*selected semesters*

Number systems, hardware/software arithmetic, overflow, significance, rounding, multiple precision, and automatic error control; impact on languages, architectures, robust programming, and software development. Prerequisite: only CSE 100 (or 200) or both MAT 421 and 423 (or 425) or only instructor approval.

**MAT 442 Advanced Linear Algebra. (3)**

*fall*

Fundamentals of linear algebra, dual spaces, invariant subspaces, canonical forms, bilinear and quadratic forms, and multilinear algebra. Prerequisites: both MAT 300 and 342 (or 343) or only instructor approval.

**MAT 443 Introduction to Abstract Algebra. (3)**

*fall*

Introduces concepts of abstract algebra. Not open to students with credit for MAT 444. Prerequisites: both MAT 300 and 342 (or 343) or only instructor approval.

**MAT 444 Intermediate Abstract Algebra. (3)**

*spring*

Basic theory of groups, rings, and fields, including an introduction to Galois theory. Appropriate as preparation for MAT 543. Prerequisite: MAT 443 or graduate standing or instructor approval.

**MAT 445 Theory of Numbers. (3)**

*spring*

Prime numbers, unique factorization theorem, congruences, Diophantine equations, primitive roots, and quadratic reciprocity theorem. Prerequisites: both MAT 300 and 342 (or 343) or only instructor approval.

**MAT 447 Cryptography. (3)**

*fall and spring*

Block ciphers, stream ciphers, congruence arithmetic, information theory, public key cryptosystems, key exchange, electronic signatures. Prerequisites: CSE 100 (or 110); MAT 242 (or 342 or 343), 300.

**MAT 451 Mathematical Modeling. (3)**

*spring*

Detailed study of 1 or more mathematical models that occur in the physical or biological sciences. May be repeated for credit with instructor approval. Prerequisites: both MAT 242 (or 342 or 343) and 274 (or 275) or only instructor approval.

**MAT 452 Introduction to Chaos and Nonlinear Dynamics. (3)**

*fall*

Properties of nonlinear dynamical systems; dependence on initial conditions; strange attractors; period doubling; bifurcations; symbolic dynamics; Smale-Birkhoff theorem; and applications. Prerequisites: MAT 274 (or 275), 342 (or 242 or 343); MAT 371 is recommended.

**MAT 455 Introduction to Fractals and Applications. (3)**

*spring*

Fractals; self-similar structures, fractals with iterated function systems of maps, computing fractals, fractal dimensions, chaotic dynamics on fractals, applications. Prerequisites: MAT 274 (or 275), 342 (or 242 or 343); MAT 371 recommended.

**MAT 460 Vector Calculus. (3)**

*spring*

Vectors, curvilinear coordinates, Jacobians, implicit function theorem, line and surface integrals, Green's, Stokes', and divergence theorems.

Not open to students with credit for MAT 372. Prerequisites: MAT 242 (or 342 or 343), 272, 274 (or 275).

**MAT 461 Applied Complex Analysis. (3)**

*fall and summer*

Analytic functions, complex integration, Taylor and Laurent series, residue theorem, conformal mapping, and harmonic functions. Prerequisite: MAT 272 (or its equivalent).

**MAT 462 Applied Partial Differential Equations. (3)**

*spring*

Second-order partial differential equations, emphasizing Laplace, wave, and diffusion equations. Solutions by the methods of characteristics, separation of variables, and integral transforms. Prerequisites: MAT 242 (or 342 or 343), 274 (or 275).

**MAT 472 Intermediate Real Analysis I. (3)**

*fall*

Introduces analysis in metric spaces with emphasis on the real line. Appropriate as preparation for MAT 570. Prerequisites: MAT 300, 342 (or 343).

**MAT 473 Intermediate Real Analysis II. (3)**

*spring*

Analysis in  $R^n$ : implicit function theorem, introduction to manifolds, Lebesgue integration, change of variables formula, convergence theorems for integrals. Prerequisite: MAT 472 or instructor approval.

**MAT 475 Differential Equations. (3)**

*fall*

Linear and nonlinear ordinary differential equations, asymptotic behavior of solutions, stability, existence and uniqueness, limit sets, Poincaré-Bendixson theorem. Prerequisites: MAT 242 (or 342 or 343), 274 (or 275), 370 (or 371) (or their equivalents) or instructor approval.

**MAT 476 Partial Differential Equations. (3)**

*spring*

First-order quasilinear, second-order linear (wave, Laplace, heat). Characteristics, harmonic functions, maximum principles, Fourier series, separation of variables. Prerequisites: MAT 242 (or 342 or 343), 274 (or 275 or 475), 370 (or 371) (or their equivalents) or instructor approval.

**MAT 484 Internship. (1–12)**

*selected semesters*

**MAT 485 History of Mathematics. (3)**

*selected semesters*

Topics from the history of the origin and development of mathematical ideas. Prerequisite: MAT 272 (or its equivalent).

**MAT 502 Neural Modeling. (3)**

*fall and spring*

Mathematical modeling electrochemical processes in nerve. Cable theory, neuronal branching, spines, bifurcation analysis of excitable membrane models. Prerequisite: MAT 274 or 275.

**MAT 503 Mathematical Cell Physiology. (3)**

*fall and spring*

Mathematical modeling of dynamical aspects of cell physiology. Diffusion, membrane transport, intracellular calcium channel kinetics, calcium oscillations and waves. Lecture, computing lab.

**MAT 504 Mathematical Aspects of Biotechnology. (3)**

*fall and spring*

Bacterial growth, bacterial genetics, gene expression, stoichiometry of metabolic pathways, random walks, diffusion processes, biofilms. Prerequisite: instructor approval.

**MAT 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 MAE 505. Credit is allowed for only MAE 505 or MAT 505.

**MAT 514 Enumerative Combinatorics I. (3)**

*fall*

First semester of a systematic development of enumerative combinatorics, including elementary counting techniques, sieve methods, and partially ordered sets. Prerequisite: graduate standing or instructor approval.

**MAT 515 Enumerative Combinatorics II. (3)**

*spring*

Second semester of a systematic development of enumerative combinatorics, including lattices, exponential structures, symmetric func-

## GRADUATE PROGRAMS AND COURSES

tions, and selected special topics. Prerequisite: MAT 514 or instructor approval.

### **MAT 516 Graph Theory I. (3)**

*fall*

First semester of a systematic development of graph theory, including matchings, connectivity, arboricity, planarity, coloring, network flows. Prerequisite: graduate standing or instructor approval.

### **MAT 517 Graph Theory II. (3)**

*spring*

Second semester of a systematic development of graph theory, including dense and sparse graphs, Ramsey theory, hamiltonicity, random graphs, minors. Prerequisite: MAT 516 or instructor approval.

### **MAT 518 Combinatorial Optimization I. (3)**

*fall*

First semester of a systematic development of combinatorial optimization, including linear programming, duality, primal-dual algorithms, network flow algorithms, weighted matchings. Prerequisite: graduate standing or instructor approval.

### **MAT 519 Combinatorial Optimization II. (3)**

*spring*

Second semester of a systematic development of combinatorial optimization, including matroid algorithms, theory of NP-completeness, polynomial time approximation, dynamic programming. Prerequisite: MAT 518 or instructor approval.

### **MAT 520 Numerical Linear Algebra. (3)**

*fall*

Direct solution of linear systems, iterative methods, eigenvalues and eigenvectors, singular value decomposition, the QR algorithm, error propagation, arithmetic, and stability. Prerequisites: both MAT 342 (or 343) and 421 (or 423) or only instructor approval.

### **MAT 521 Iterative Methods. (3)**

*spring*

Numerical methods for solving linear/nonlinear systems of equations (symmetric, nonsymmetric). Iterative methods for linear systems, conjugate gradients, multigrid methods, preconditioning, Krylov methods. Prerequisites: both MAT 371 and 423 (or 421) or only instructor approval.

### **MAT 523 Numerical Optimization. (3)**

*selected semesters*

Linear programming, unconstrained nonlinear minimization, line search algorithms, conjugate gradients, quasi-Newton methods, constrained nonlinear optimization, gradient projection, and penalty methods. Prerequisite: MAT 342 or 343 or 371 or 460 or 520 (or its equivalent) or instructor approval.

### **MAT 524 Parallel Numerical Algorithms. (3)**

*selected semesters*

Algorithms for massively parallel, hypercube architectures; "parallel" FORTRAN; solution of linear, nonlinear systems; partial differential equations; iterative methods; multigrid; domain decomposition. Prerequisites: both MAT 371 and 423 (or 421) or only instructor approval.

### **MAT 530 Numerical Solution of Ordinary Differential Equations. (3)**

*fall*

One-step, linear multistep methods; consistency, order, stability, convergence; discretization, roundoff errors, error estimation, adaptive strategy; implementation, software for nonstiff equations. Prerequisites: both MAT 371 and 423 (or 421) or only instructor approval.

### **MAT 531 Numerical Solution of Stiff Differential Systems. (3)**

*spring*

Runge-Kutta methods, order conditions, construction of highly stable methods, order stars, error estimation, stepsize selection, contractivity properties, linear multistep methods. Prerequisites: both MAT 371 and 423 (or 421) or only instructor approval.

### **MAT 533 Computational Elliptic and Parabolic Partial Differential Equations. (3)**

*fall*

Parabolic and elliptic equations, finite difference, finite element methods, stability, consistency, convergence, practical aspects, applications, software. Prerequisites: both MAT 371 and 423 (or 421) or only instructor approval.

### **MAT 534 Computational Hyperbolic Partial Differential Equations. (3)**

*spring*

Numerical solutions of hyperbolic PDEs, finite difference methods, well-posedness, stability, consistency, convergence, adaptive grids; Maxwell's equations, elastic wave propagation; Navier-Stokes. Prerequisites: both MAT 371 and 423 (or 421) or only instructor approval.

### **MAT 535 Spectral Methods for Partial Differential Equations. (3)**

*selected semesters*

Spectral, pseudospectral theory; Galerkin, collocation methods; Tau-methods, global approximation properties, stability; convergence; solutions for linear, nonlinear systems. Prerequisites: both MAT 371 and 423 (or 421) or only instructor approval.

### **MAT 543 Abstract Algebra. (3)**

*fall*

Groups, modules, rings and fields, Galois theory, homological algebra, and the representation theory. Prerequisite: MAT 444 or instructor approval.

### **MAT 544 Abstract Algebra. (3)**

*spring*

Continuation of MAT 543. Prerequisite: MAT 543 or instructor approval.

### **MAT 551 Linear Operators and Integral Equations. (3)**

*spring*

Bounded linear and compact operators on Hilbert spaces. Linear integral equations, Fredholm and Hilbert-Schmidt theory, and approximate methods. Distributions. Prerequisites: MAT 242 and 462 (or their equivalents).

### **MAT 555 Fractal Geometry. (3)**

*selected semesters*

Geometry and analysis of fractal sets; definitions of dimensions; calculating dimensions; projections, products of fractals; random fractals; multifractal measures; and applications. Prerequisites: MAT 371, 455; MAT 472 recommended.

### **MAT 560 Dynamical Systems Methods in Fluid Dynamics. (3)**

*fall*

Applies modern dynamical systems methods to fluid mechanics: bifurcations, normal forms, nonlinear dynamics, pattern formation, mixing, and Lagrangian chaos. Prerequisite: graduate standing or instructor approval.

### **MAT 562 Nonlinear Analysis of PDEs in Fluids. (3)**

*spring*

Sobolev spaces; incompressible Euler and Navier-Stokes equations; weak and strong solutions; attractors and the connection with turbulence; geophysical applications. Prerequisite: graduate standing or instructor approval.

### **MAT 570 Real Analysis. (3)**

*spring*

Lebesgue integration, selected function spaces, differentiation, abstract measure theory, and elements of functional analysis. Prerequisite: MAT 372 or instructor approval.

### **MAT 571 Real Analysis. (3)**

*fall*

Continuation of MAT 570. Prerequisite: MAT 570 or instructor approval.

### **MAT 572 Complex Analysis. (3)**

*fall*

Analytic functions, series and product representations, entire and meromorphic functions, normal families, Riemann mapping theorem, harmonic functions, and Riemann surfaces. Prerequisite: MAT 371 or instructor approval.

### **MAT 573 Complex Analysis. (3)**

*spring*

Continuation of MAT 572. Prerequisite: MAT 572 or instructor approval.

### **MAT 574 Theory of Ordinary Differential Equations. (3)**

*selected semesters*

Systems, existence proofs, singularities, asymptotic behavior of solutions, boundedness of solutions, eigenvalues and eigenfunctions, and perturbation theory. Prerequisite: MAT 372 or instructor approval.

**MAT 575 Theory of Ordinary Differential Equations and Dynamical Systems. (3)**

*selected semesters*

Geometric approach to ODEs and dynamical systems; (un)stable, center manifolds; structural stability; normal forms; averaging; chaos; persistence. May be repeated for credit with instructor approval. Prerequisites: both MAT 452 and 475 or only MAT 574 or only instructor approval.

**MAT 576 Theory of Partial Differential Equations. (3)**

*selected semesters*

Existence and uniqueness theorems, boundary value and initial value problems, characteristics, Green's functions, maximum principle, distributions, and weak solutions. Prerequisite: knowledge of Lebesgue integration or instructor approval.

**MAT 577 Theory of Partial Differential Equations. (3)**

*selected semesters*

Continuation of MAT 576. Prerequisite: MAT 576 or instructor approval.

**MAT 578 Functional Analysis. (3)**

*selected semesters*

Locally convex, normed, and Hilbert spaces. Linear operators, spectral theory, and application to classical analysis. Prerequisite: MAT 472 or 571 or instructor approval.

**MAT 579 Functional Analysis. (3)**

*selected semesters*

Continuation of MAT 578. Prerequisite: MAT 578 or instructor approval.

**MAT 591 Seminar. (1–12)**

*selected semesters*

Topics may include the following:

- Algebra. (1–3)
- Analysis. (1–3)
- Applied Mathematics. (1–3)
- Combinatorial Mathematics. (1–3)
- Mathematical Logic. (1–3)
- Numerical Analysis. (1–3)
- Topology. (1–3)

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 50.

**MATHEMATICS EDUCATION (MTE)**

**MTE 482 Methods of Teaching Mathematics in Secondary School. (3)**

*fall*

Examines secondary school curricular material and analyzes instructional devices. Teaching strategies, evaluative techniques, diagnosis, and remediation and problem solving. Fee. Prerequisite: instructor approval.

**MTE 483 Mathematics in the Secondary School. (3)**

*spring*

Topics in geometry, number theory, algebra, and analysis. Emphasizes unifying principles. Prerequisite: MAT 310 or instructor approval.

**MTE 585 Modern Geometry for Teachers. (3)**

*once a year*

Euclidean, projective, and non-Euclidean geometries. Fee. Prerequisite: instructor approval.

**MTE 587 Analysis for Teachers. (3)**

*selected semesters*

Subject matter in mathematics appropriate for accelerated programs in secondary schools, including analytic geometry and calculus. Prerequisite: instructor approval.

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 50.

**STATISTICS AND PROBABILITY (STP)**

**STP 420 Introductory Applied Statistics. (3)**

*fall, spring, summer*

Introductory probability, descriptive statistics, sampling distributions, parameter estimation, tests of hypotheses, chi-square tests, regression analysis, analysis of variance, and nonparametric tests. Prerequisite: MAT 113 or 117 (or its equivalent).

**STP 421 Probability. (3)**

*fall*

Laws of probability, combinatorial analysis, random variables, probability distributions, expectations, moment-generating functions, transformations of random variables, and central limit theorem.

Prerequisite: MAT 272 (or its equivalent).

**STP 425 Stochastic Processes. (3)**

*spring*

Markov chains, stationary distributions, pure jump processes, 2-D order processes, and other topics in stochastic processes. Prerequisites: MAT 342; STP 421.

**STP 427 Mathematical Statistics. (3)**

*spring*

Limiting distributions, interval estimation, point estimation, sufficient statistics, and tests of hypotheses. Prerequisites: a combination of MAT 371 and STP 420 and 421 or only instructor approval.

**STP 429 Experimental Statistics. (3)**

*spring*

Statistical inference for controlled experimentation. Multiple regression, correlation, analysis of variance, multiple comparisons, and non-parametric procedures. Prerequisite: STP 420 (or its equivalent).

**STP 525 Advanced Probability. (3)**

*selected semesters*

Measure-theoretic foundations of probability, distribution functions and characteristic functions, laws of large numbers and central limit theorems, conditional probabilities, martingales, and topics in stochastic processes. Prerequisites: both MAT 571 and STP 421 or only instructor approval.

**STP 526 Theory of Statistical Linear Models. (3)**

*fall*

Multinormal distribution, distribution of quadratic forms, full and nonfull rank models, generalized inverses, unbalanced data, variance components, and the large sample theory. Prerequisites: STP 427; knowledge of matrix algebra.

**STP 530 Applied Regression Analysis. (3)**

*fall*

Method of least squares, simple and multiple linear regression, polynomial regression, analysis of residuals, dummy variables, and model building. Prerequisite: STP 420 (or its equivalent).

**STP 531 Applied Analysis of Variance. (3)**

*spring*

Factorial designs, balanced and unbalanced data, fixed and random effects, randomized blocks, Latin squares, analysis of covariance, and multiple comparisons. Prerequisite: STP 420 (or its equivalent).

**STP 532 Applied Nonparametric Statistics. (3)**

*fall*

One-sample test, tests of 2 or more related or independent samples, measures of correlation, and tests of trend and dependence. Prerequisite: STP 420 (or its equivalent).

**STP 533 Applied Multivariate Analysis. (3)**

*spring*

Discriminant analysis, principal components, factor analysis, cluster analysis, and canonical correlation. Prerequisite: STP 420 (or its equivalent).

**STP 534 Applied Discrete Data Analysis. (3)**

*selected semesters*

Models for discrete and count data, measures of association, and log-linear and regression models for contingency tables. Prerequisite: STP 420 (or its equivalent).

**STP 535 Applied Sampling Methodology. (3)**

*spring*

Simple random, stratified, cluster sampling; variance estimation in complex surveys; nonparametric superpopulation approaches; non-response models; computational methods. Prerequisite: STP 420 (or its equivalent).

**STP 591 Seminar. (1–12)**

*selected semesters*

Topics may include the following:

- Probability. (1–3)
- Statistics. (1–3)

**Omnibus Courses.** For an explanation of courses offered but not specifically listed in this catalog, see "Omnibus Courses," page 50.