Fall Semester (2151)

August 18 - 23
New Student Orientation
August 24
Day, evening, and online classes begin
First day of 6-day Add/Drop period†
August 29
Saturday classes begin
August 31
Last day of 6-day Add/Drop period†
September 7
Labor Day (no classes); University offices closed
September 3
First day to drop from classes with a grade of W
October 12
Columbus Day (no classes); University offices open
November 13
Last day to drop from classes with a grade of W†
November 25
No classes; University offices open
November 26 - 27
Thanksgiving Holiday (no classes); University offices closed
November 28
No Saturday classes
November 30
Day, evening, and online classes resume
December 5
Saturday classes resume
December 11
Last day, evening, and online classes
December 12
Last Saturday classes.
Dec. 14, 15, 16, 17, 18
Final exams
December 19
Residence halls close
Dec. 21 - Jan. 24
Holiday break; University closed
January 5
Day, evening, and online classes begin
First day of 3-day Add/Drop period†
January 6
Last day of 3-day Add/Drop†
January 7
First day to drop from classes with a grade of W
January 11
Last day to drop from classes with a grade of W
January 21
Last day of classes
January 22
Final exams
January 23 - 24
Break between Inter session and spring semester

Intersession (2153)

January 18
Residence halls open
January 25
Day, evening, and online classes begin
First day of 6-day Add/Drop period†
January 30
Saturday classes begin
February 1
Last day of 6-day Add/Drop period†
February 2
First day to drop from classes with a grade of W
March 21 - 25
No classes (spring break); University offices open
March 26
No Saturday classes
March 28
Day, evening, and online classes resume
April 22
Last day to drop from classes with a grade of W†
May 13
Last day, evening, and online classes
May 14
Last Saturday classes
May 16, 17, 18, 19, 20
Final exams
May 20
Convocation and Commencement ceremonies
May 21
Commencement ceremonies
May 24
Final grades due
May 23 - 28
Break between spring semester and summer terms
May 30
Memorial Day; University closed

Spring Semester (2155)

January 18
Residence halls open
January 25
Day, evening, and online classes begin
First day of 6-day Add/Drop period†
January 30
Saturday classes begin
February 1
Last day of 6-day Add/Drop period†
February 2
First day to drop from classes with a grade of W
March 21 - 25
No classes (spring break); University offices open
March 26
No Saturday classes
March 28
Day, evening, and online classes resume
April 22
Last day to drop from classes with a grade of W†
May 13
Last day, evening, and online classes
May 14
Last Saturday classes
May 16, 17, 18, 19, 20
Final exams
May 20
Convocation and Commencement ceremonies
May 21
Commencement ceremonies
May 24
Final grades due
May 23 - 28
Break between spring semester and summer terms
May 30
Memorial Day; University closed

10-week Summer Session (2158)

May 31
Day, evening, and online classes begin
First day of 7-day Add/Drop period†
June 4
Saturday classes begin
June 7
Last day to Add/Drop classes†
June 8
First day to drop from classes with a grade of W†
July 4
Independence Day celebrated (no classes); University closed
July 22
Last day to drop from classes with a grade of W‡
August 5
Last day, evening, and online classes
August 6
Last Saturday classes
August 9, 10, 11, 12
Final exams
August 15
Final grades due
August 15 - 19
Summer/Fall break

5-week Summer Session I (2158)

May 31
Day, evening, and online classes begin
First day of 3-day Add/Drop period†
June 2
Last day to Add/Drop classes†
June 3
First day to drop from classes with a grade of W
June 17
Last day to drop from classes with a grade of W (4 weeks)
July 1
Last day of classes (final exams held)
July 5
Final grades due

5-week Summer Session II (2158)

July 5
Day, evening, and online classes begin
First day of 3-day Add/Drop period†
July 7
Last day to Add/Drop classes†
July 8
First day to drop from classes with a grade of W
July 22
Last day to drop from classes with a grade of W (4 weeks)
August 5
Last day of classes (final exams)
August 9, 10, 11, 12
Final exams
August 15
Final grades due
August 15 - 19
Summer/Fall break

RIT does not discriminate. RIT promotes and values diversity within its workforce and provides equal opportunity to all qualified individuals regardless of race, color, creed, age, marital status, sex, gender, religion, sexual orientation, gender identity, gender expression, national origin, veteran status, or disability.

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Course Number Index

RIT course numbering: Throughout this bulletin and in registration materials that are published every semester, courses are generally referred to by their alpha-numeric registration label. The four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100–299), upper division (300–599), or graduate level (600 and above).

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<thead>
<tr>
<th>College of Applied Science and Technology</th>
<th>College of Imaging Arts and Sciences</th>
<th>Golisano Institute for Sustainability</th>
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<tbody>
<tr>
<td>ESHS  Environmental, Health and Safety Management</td>
<td>ARTH  Art History</td>
<td>ARCH  Architecture</td>
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<tr>
<td>FMGC  Facility Management</td>
<td>CCESS  Ceramics</td>
<td>ISUS  Sustainability</td>
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<tr>
<td>GRCS  Graduate Writing and Research Courses</td>
<td>FNAS  Fine Arts Studio</td>
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<td>HSPT  Hospitality Management</td>
<td>ILLS  Fine Arts Studio</td>
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<td>HRDE  Human Resource Development</td>
<td>IGEI  General Crafts Studies</td>
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<tr>
<td>MCEF  Manufacturing and Mechanical Engineering Technology</td>
<td>CGLS  Glass</td>
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<td>MFET  Manufacturing and Mechanical Engineering Technology</td>
<td>CGF  Graduation Photography</td>
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<tr>
<td>PACK  Packaging Science</td>
<td>IDOE  Industrial Design</td>
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<tr>
<td>SERQ  Service Leadership and Innovation</td>
<td>IADI  Interdisciplinary Imaging Arts</td>
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<tr>
<td>TCET  Telecommunications Engineering Technology</td>
<td>CMJT  Metals and Jewelry Design</td>
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<td>CSCI  Computing and Information Sciences</td>
<td>PPRT  Printing Management</td>
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<td>CISC  Computing and Information Sciences</td>
<td>STSO  Science, Technology and Society</td>
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<td>STAT  Statistics</td>
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Saunders College of Business

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<thead>
<tr>
<th>ACCT  Accounting</th>
<th>COMM  Communication and Media Technology</th>
<th>ARCH  Architecture</th>
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<tbody>
<tr>
<td>BLEG  Business Legal Studies</td>
<td>CRIM  Criminal Justice</td>
<td>ISUS  Sustainability</td>
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<tr>
<td>DECS  Decision Sciences</td>
<td>ENGL  English</td>
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<td>ESCB  Economics</td>
<td>ENGL  Experimental Psychology</td>
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<tr>
<td>FINC  Finance</td>
<td>PHIL  Philosophy</td>
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<tr>
<td>INTB  International Business</td>
<td>PUBL  Public Policy</td>
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<tr>
<td>MGMT  Management</td>
<td>SPSY  School Psychology</td>
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<tr>
<td>MGIS  Management Information Systems</td>
<td>STSO  Science, Technology and Society</td>
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<td>MKTG  Marketing</td>
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B. Thomas Golisano College of Computing and Information Sciences

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<tr>
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<td>HCIN  Information Sciences and Technologies</td>
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<td>MEDI  Information Sciences and Technologies</td>
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<td>ISTE  Information Sciences and Technologies</td>
<td>IGME  Interactive Games and Media</td>
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<td>NASS  Networking, Security and Systems Administration</td>
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<td>SWEN  Software Engineering</td>
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Kate Gleason College of Engineering

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<td>ISEE  Industrial and Systems Engineering</td>
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<td>MCE  Mechanical Engineering</td>
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<td>MCE  Microelectronic Engineering</td>
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College of Health Sciences and Technology

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<td>ILLM  Medical Illustration</td>
<td>ILEH  Mathematics</td>
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College of Liberal Arts

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<td>BUDS  Business Administration Management</td>
<td>CSCI  Computer and Information Sciences</td>
<td>CSCI  Computer and Information Sciences</td>
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<td>PROF  Professional Studies</td>
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<td>TCOM  Technical Communication</td>
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Center for Multidisciplinary Studies

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<td>PRO  Professional Studies</td>
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<td>TCOM  Technical Communication</td>
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National Technical Institute for the Deaf

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<tr>
<th>NCOM  Deafness Specialty Preparation Program in Speech-Language Pathology</th>
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<td>MSSE  Secondary Education of Students</td>
<td>MSSE  Secondary Education of Students</td>
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<td>WOS  Who Are Deaf or Hard of Hearing</td>
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College of Science

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Environmental, Health and Safety Management

ESHS-601 Fire Protection
Introduces fundamental concepts in protection of industrial workers and property from fire and explosion. Fire chemistry, control of ignition sources in industry, and properties of combustible materials are discussed. Fire detection and extinguishment are covered along with building construction for fire prevention, fire safety, fire codes and related topics. (This course is restricted to students in the EHSMS program.) Lecture, Credits 3 (Fall)

ESHS-611 Occupational Health
This course will provide students with an overview of the fundamentals of industrial hygiene. Emphasis will be on the toxicological effects of various industrial substances on the body; monitoring and personal sampling for these substances and personal protection against such substances. (This course is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring)

ESHS-613 Solid and Hazardous Waste Management
An examination of strategies and technologies to move an organization toward environmental sustainability, including: resource use reduction, material substitution, process and product modification, and waste minimization; and for handling and managing wastes including: treatment, storage, transport and disposal storing solid and hazardous waste. Associated environmental impacts, regulatory concerns, technical feasibility and costs are considered. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring)

ESHS-614 Industrial Wastewater Management
This course investigates characteristics and sources of industrial wastewaters, related environmental impacts, regulatory implications, and technical considerations of current treatment and disposal methodologies. Students learn to identify appropriate methods, technologies and sequences for source reduction, treatment and pretreatment, direct discharge and management of treatment residuals. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall)

ESHS-615 Air Emissions Management
This course will present an overview of industrial air pollution management: its sources, methods of reduction, control and management. Students will become familiar with the history of air pollution, the chemistry and effects of pollutants, regulations and standards, and control technologies; as well as developing analytical and quantitative skills necessary in air emissions management decision-making. By the end of the course, students will be able develop a comprehensive facility air emissions management plan. (College level chemistry. Students who have completed ESHS-350 may not take this course. (This course is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring)

ESHS-626 Exposure Assessment and Analysis
The course focuses on industrial hygiene applications and hands on participation. Particular attention will be given to sampling strategies - from similar exposure grouping, actual sampling experiences with a wide range of industrial hygiene instruments, and sampling analysis using statistical protocols. Field experience with instrumentation, as well as professional written and oral communication of results is emphasized. There are several out of classroom learning experiences required (team based). Lecture/Lab 4, Credits 3 (Fall, Spring)

ESHS-630 Mechanical and Electrical Controls and Standards
Discussion of machine safety with emphasis on hazard analysis, risk estimation, safeguarding techniques, and electrical safety. Particular attention will be paid to applicable OSHA, ANSI, NFPA, and EN standards as they relate to wood, metal, films and automation. Elements of the course will change regularly to reflect emerging issues in industry. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall, Spring)

ESHS-699 Students will have the opportunity to gain appropriate work experience and applied knowledge of the profession working in one or more EHS areas. The graduate committee determines whether enrollment for one or more co-op semesters will be required. Co-op, Credits 0

ESHS Co-op

ESHS-722 EHS Law
An overview of environmental, health and safety (EHS) related law with an emphasis on legislativelaw. Topics include a review of the historical and modern sources for EHS law, the emergence of administrative law and the responsibilities of the separate branches of government. Major EHS related legislation and their impact on EHS management systems will be covered. (This course is restricted to students in the EHSMS program.) Lecture, Credits 3 (Spring)

ESHS-725 EHS Accounting and Finance
This course focuses on the environmental, health, and safety (EHS) costs of business decisions. Methods will be taught to identify and quantify EHS related costs and benefits that can lead an organization towards a more sustainable future. (FCMG-MS, EHSMS-MS) Lecture, Credits 3 (Fall)

ESHS-750 EHS and FM Project Management
This course has been designed to give the student an overview of the fundamental concepts of modern project management. Areas of focus include the project life cycle (PLC), the project management body of knowledge (PMBOK), program evaluation review technique (PERT), critical path method (CPM) and various budgeting and resource allocation techniques. Discussion of project management organizations, negotiation and conflict resolution and project termination will be included, along with an introduction to Project Management Institute (PMI) and Microsoft Project for Windows. (FCMG-MS, EHSMS-MS) Lecture, Credits 3 (Spring)

ESHS-755 Corporate Social Responsibility
This course will introduce social responsibility concepts and approaches presented in key documents like the ISO 26000 Social Responsibility Standard, and will explore strategies for assisting an organization to identify and implement socially responsible initiatives appropriate to the nature and scope of its activities, products and services. (This course is restricted to students in the EHSMS program.) Lecture, Credits 3 (Fall)

ESHS-760 Integrating EHS Management
This course examines strategies for integrating EHS systems and processes. Using case studies, the course explores interrelationships between EHS and: total quality management, business value, reporting, and approaches for sustainable business development. Students will be prepared to select appropriate quality tools to improve EHS processes; identify opportunities, strategies and tools for integrating EHS into business management; and identify best practices in EHS/business integration. (Prerequisites: ESHS-720 or equivalent course.) Lecture, Credits 3 (Spring)

ESHS-765 Product Stewardship
This course examines the principles of product stewardship, including the ethical, legal, and economic issues that product manufacturers face. Students will be exposed to the principles and practices used to identify and manage product environmental, health and safety (EHS) aspects and impacts. Sustainability will be covered and case studies will be reviewed. (This course is restricted to students in the EHSMS program.) Lecture, Credits 3 (Fall)

ESHS-770 Risk Assessment, Management and Communication
This course focuses on risk management systems, including implementation of risk management and risk reduction strategies; The course includes case studies and application of risk analysis, technologies for risk, cost benefit analysis and decision-making under uncertainty in a corporate environment. Risk communication strategies are examined as an integral step in the risk management process. (Prerequisites: ESHS-611 or equivalent course.) Lecture, Credits 3 (Spring)
This course covers the development and use of EHS management system checking and corrective action techniques, including auditing. The course also addresses the issues and elements for designing and managing an internal EHS audit program. Exercises provide opportunities to apply checking and corrective action skills and techniques. (Prerequisites: ESHS-720 or equivalent course.) Lecture, Credits 3 (Fall)

**ESHS-790**
EHS Systems Review and Auditing
This course will provide a forum for independent review of the main concepts of the program core subject areas. The student will take a written examination at the conclusion of the course and must receive a passing grade of at least 80% to be successful. Students will have one additional opportunity to pass this examination if their initial attempt is unsuccessful. (Enrollment in this course requires permission from the department offering the course.) Lecture, Credits 3 (Fall, Spring)

**ESHS-792**
Continuation of Thesis
Continuation of Thesis (Enrollment in this course requires permission from the department offering the course.) Continuation, Credits 0

**ESHS-795**
Comprehensive Exam
A written comprehensive exam is one of the non-thesis methodologies for completion of the MS degree. This course will provide students with the knowledge and tools to manage property assets as an investment and/or profit center. The concepts covered in this course include: Asset Management, Master Planning, Property Acquisition & Disposal, Interior Programming, Space Planning, Property & Facility Design Parameters, Regulatory & Legal Issues, Market & Financial Analysis, Ownership & Leasing Management, Constituent Service, Inventory Control, and Future Trends. All relevant issues from planning for facility needs to life-cycle property management through ultimate property disposition are covered in this course. (Prerequisites: FCMG-660 or equivalent course.) Lecture, Credits 3 (Fall)

**FCMG-740**
Real Estate in Facility Management
This course has been designed to give the student the knowledge and tools to manage property assets as an investment and/or profit center. The concepts covered in this course include: Asset Management, Master Planning, Property Acquisition & Disposal, Interior Programming, Space Planning, Property & Facility Design Parameters, Regulatory & Legal Issues, Market & Financial Analysis, Ownership & Leasing Management, Constituent Service, Inventory Control, and Future Trends. All relevant issues from planning for facility needs to life-cycle property management through ultimate property disposition are covered in this course. (Prerequisites: FCMG-660 or equivalent course.) Lecture, Credits 3 (Fall)

**FCMG-788**
Thesis Planning
Students will rigorously develop their thesis research ideas, conduct literature reviews, identify and plan methodologies, prepare schedules, and gain a clear understanding of the expectations of the faculty and the discipline. Each student will be required to prepare a committee approved thesis research proposal and may begin work on their thesis. (Enrollment in this course requires permission from the department offering the course.) Lecture, Credits 3 (Fall, Spring)

**FCMG-790**
Thesis
The graduate thesis is a formal research document that empirically relates theory with practice. A formal written thesis and oral defense are required. (Prerequisites: Grade of B or better in ESHS-788 or equivalent course.) Thesis, Credits 3 (Fall, Spring)

**FCMG-797**
Graduate Project
A supervised investigation within a facility management area of student interest. Consent of the faculty and the discipline. Each student will be required to prepare a committee approved thesis research proposal and may begin work on their thesis. (Enrollment in this course requires permission from the department offering the course.) CMP, Credits 0 (Fall, Spring)

**FCMG-799**
Independent Study
A supervised investigation within a facility management area of student interest. Consent of the faculty sponsor and departmental approval are required. Students are limited to a maximum of three semester credit hours of independent study projects and two sections in any semester, and a maximum of six semester credit hours of independent study used to fulfill degree requirements. Independent Study, Credits 1 - 3 (Fall, Spring)

**FCMG-660**
Principles and Practice in Facility Management
The course is restricted to students in the FCMG-MS program.) Lecture, Credits 3 (Fall)

**FCMG-699**
FCMG Co-op
FCMG Co-op, Credits 0

**FCMG-720**
EHS in Facility Management
According to the International Facility Management Association the primary goal of facility managers is the management of safe, humane and functional work environments in the context of sound ecological practices. This course will provide students with a solid foundation in environmental, health and safety management which will enhance their ability to develop and implement practices that promote and protect health, safety, security, the quality of work life, the environment and organizational effectiveness pertaining to facilities. Topics examined include: EHS moral, legal and economic issues, EHS related laws and regulations (OSHA, EPA, ADA), principles of accident causation and prevention, EHS management systems, fire protection and life safety codes, emergency preparedness, ergonomics, indoor air quality, mold, solid and hazardous waste, recycling, sustainable design, other environmental related issues, environmental psychology and impacts of facilities on individual, group and organizational performance, comfort and satisfaction. (Prerequisites: FCMG-660 or equivalent course.) Lecture, Credits 3 (Spring)

**FCMG-730**
Strategic Hospitality and Tourism Branding
This class will concentrate on how the differences between product and service branding and marketing apply to travel destinations and tourist services such as lodging and recreational activities. Specific emphasis will be placed on the branding and marketing of tourism suppliers. Special attention will also be paid to promoting destinations as they move through their life cycle. The role of experiences in the marketing system will be covered from both the destination and supplier perspective. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall)

**HSPT-730**
Economic Performance Analysis for Hospitality and Tourism
Applications of economic analysis to hospitality and tourism including estimation and prediction of demand and supply, valuation, determination of regional economic impacts, and use of economic analysis in management, marketing and policy decisions. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring)
College of Applied Science and Technology

HSPT-750  Strategic Processes and Assessment of Hospitality and Tourism Industries
This course will apply customer relationship management methods to hospitality and tourism industries in order to develop new service experiences and maintain the economic viability of others. A review of the quality models and strategies available for maintaining hospitality and tourism competitiveness will be covered. The use of the six sigma quality improvement process will be applied to hospitality industries. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Spring)

HSPT-761  Planning and Development for Hospitality and Tourism Industries
This course analyzes tourism as a system of interrelationships between markets (demand) and destinations (supply) and between governments and private businesses. This analysis provides a framework for the in-depth study of policy initiatives at the local, regional, and international levels. Additionally this course will address tourism & hospitality planning as it defines the frames of reference used in making choices concerning the development of tourism facilities and use of space. Scenario planning will be used to create new service systems for hospitality & tourism industries. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall)

HSPT-763  Resort Amenity and Attraction Development
This course gives the student an understanding of how resort amenities and visitor attractions are developed and managed in destinations. Focus is on the planning, development, operation, design and special needs of recreational amenities such as golf, tennis, skiing, spas and marinas. Additional emphasis is placed on managing both historical, cultural and natural resource based tourist attractions. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall)

HSPT-765  Travel Transportation and Distribution Services
This course will provide in-depth knowledge of the role travel intermediaries play in the tourism system. Focus will be given to the use of electronic global distribution systems used in the transportation sector. Travel demand and performance characteristics and costs of transportation modes will also be addressed. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring)

HSPT-767  Convention and Event Management
This course provides the student an opportunity to explore the function of a convention from the point of view of the convention center manager. Consideration is given to various methods used to sell a location to an event planner and the servicing of large groups. Students also examine the various ways to evaluate floor and meeting space as to profitability and quality related to the goals and objectives of the client. Various forms of business are ranked and the ability of one convention to enhance a second are considered in the decision making process. Finally codes, regulations and licensing considerations are explored. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring)

HSPT-769  Technology Applications in the Hospitality and Tourism Industries
Survey of computer and information systems for planning and control in hospitality and tourism operations. Various software and hardware packages are examined in relation to planning and control functions. The use of technology to innovate and manage new hospitality experiences is explored. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring)

HSPT-789  Graduate Special Topic
Graduate Special Topic (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 4, Credits 1 - 4 (Fall, Spring, Summer)

HSPT-790  Research Thesis
A thesis is based on experimental evidence obtained by the candidate in an appropriate topic demonstrating the extension of theory into practice. A written proposal which is defended and authorized by the faculty advisor/committee followed by a formal written thesis and oral presentation of findings are required. Typically the candidate will have completed Research methods, Data analysis and Graduate writing strategies prior to enrolling in this course and will start the thesis process as soon as they have completed these courses to allow them to finish the thesis when they have finished their coursework. The candidate must obtain the approval of their Graduate advisor who will guide the thesis before registering for this course. Thesis, Credits 6 (Fall, Spring, Summer)

HSPT-791  Continuation of Project
Continuation of Project Continuation, Credits 0

HSPT-794  Integrative Problem Solving
Students will demonstrate synthesis and integration of the theories and foundation principles of their discipline. This will be achieved through application of core knowledge in a series of progressive problem situations culminating in a comprehensive examination. To be successful students must receive a passing grade of at least 80% in the course to be allowed to take the comprehensive exam. Lecture, Credits 3 (Fall, Summer)

HSPT-795  Comprehensive Examination
A written comprehensive exam is one of the non-thesis methodologies for completion of the MS degree. Students will demonstrate a fundamental knowledge of the theories and foundation principles. This course will include a review of the main concepts of each of the core subjects and at the conclusion of the course the student will take a written examination and must receive a passing grade of at least 80% to be successful. Students will have one additional opportunity to pass this examination if their initial attempt results in a failing grade. (This course will be taken with not less than 16 hours of coursework remaining to complete the program, completion of core courses and the student should be currently enrolled in the program. Possess a GPA of 3.0 or higher; No outstanding incomplete grades, nor can the student be on academic/ disciplinary probation; CMP, Credits 0 (Fall, Summer)

HSPT-798  Continuation of Thesis
Continuation of Thesis Continuation, Credits 0

HSPT-799  Independent Study
An opportunity for the advanced student to undertake independent investigation in a special area under the guidance of a faculty member. A written proposal is to be forwarded to the sponsoring faculty member and approved by the director of the program prior to registering for this course. The independent study must seek to answer questions outside the scope of regular course work. Independent Study, Credits 1 - 6

Human Resource Development

HRDE-710  Foundations in Human Resource Development
This course introduces students to the concepts that are the foundation of HRD and how these concepts are applied in a real-world environment. Human resource development is a distinct and unique area of practice that focuses on aligning employee learning and development with the strategic direction of an organization. This course provides an orientation to the profession; explores historical perspectives, theoretical foundations and the practice of HRD (This course is restricted to student in the HRDE-MS program.) Lecture, Credits 3 (Fall, Spring)

HRDE-711  Program Evaluation and Design
This course teaches the systematic application of social research procedures to evaluate the conceptualization, design, implementation, and utility of human resource development programs. (This course is restricted to student in the HRDE-MS program.) Lecture, Credits 3 (Spring)

HRDE-712  Performance Analysis and Development
This course provides individuals with a framework needed to successfully analyze performance and design learning interventions that drive performance improvements in an organization. Students will examine performance measurement, adult learning principles and learning styles as well as best practices in organizational learning, employee development, and alternative delivery strategies. Additionally, students will identify how to link learning initiatives with strategy and gain commitment to those initiatives from senior leaders. (This course is restricted to student in the HRDE-MS program.) Lecture, Credits 3 (Fall, Summer)

HRDE-715  Human Performance Design and Development
A systematic approach to improve organizational productivity and competence of the internal workforce. It is a process of selection, analysis, design, development, implementation and evaluation of programs to allow the most cost effective influence on human behavior and accomplishment to solve organizational problems. (This course is restricted to student in the HRDE-MS program.) Lecture 3, Credits 3 (Fall, Summer)

HRDE-720  Theories of Organizational Development
As organizations undergo continual change, HR leaders play a pivotal role enabling their organizations to anticipate, plan and profit from change. This course introduces the student to theories and practices of organization development and change leadership. Such leadership requires competencies of identifying and framing challenges, consulting with clients, researching solutions, creating, implementing, and evaluating action plans. Through study, practice and application, students will gain knowledge and skills to foster change, innovation, and the adaptability of an organization. (Prerequisites: HRDE-710 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

HRDE-721  Organizational Learning and Knowledge Management
This is an introductory graduate-level survey course for organizational learning and knowledge management. The course will provide a broad overview of the concepts, practices, and challenges associated with learning in organizational contexts. Principles, techniques, and structures used to create, capture, store, value, distribute, and leverage knowledge to enhance organizational performance in continuously changing environments will be examined. Topics covered include the types and nature of knowledge, levels of organizational learning, communities of practice, social and technological systems for capturing, storing, and distributing knowledge, valuation of knowledge assets, innovation and creativity, barriers to organizational learning, and knowledge as a source of competitive advantage. (Prerequisites: HRDE-710 or equivalent course.) Lecture, Credits 3 (Fall, Spring)
HRDE-722 Talent Development
This course provides skills to develop, retain, and engage the best available talent required for current and future success. Students examine benchmark practices from all industry types to derive effective strategies for their own organizations, develop a human capital strategy development and complete an integrated set of projects to implement selected components of the strategy. (Prerequisites: HRDE-710 or equivalent course.) Lecture, Credits 3 (Fall, Spring, Summer)

HRDE-723 Group Dynamics and Leadership
The group dynamics course explores the current theories and models of how individuals work together. Students will learn how to effectively manage, lead, and generate results from group processes. More specifically, this course will explore how groups function and the importance of effectively leading a group towards a specific outcome. Course focuses on Human Resource Development applications and problem solving and not on Human Resource Management. (Prerequisites: HRDE-710 or equivalent course.) Lecture, Credits 3 (Spring, Summer)

HRDE-730 Theories of Adult Learning
This course examines the physiological, psychological, and socio-cultural factors related to adult learning and development. Selected theories of learning and development are critically analyzed and applied to adult contexts. Students are expected to critically examine their own assumptions and beliefs about learning and development. Attention is given to stages of adult growth, the development of learning goals, learning environments, and to a variety of theories of learning. (Prerequisites: HRDE-710 or equivalent course.) Lecture, Credits 3 (Fall, Spring, Summer)

HRDE-731 Team Process and Facilitation Skills
The ability to build a functioning team and then facilitate the group process ranks among the most critical competencies for HRD practitioners today. HRD practitioners are required to develop work teams and facilitate a variety of events from meetings and new employee orientations to training sessions. This course provides the HRD practitioner with the skills required to effectively develop teams, and plan for and facilitate a variety of events. Individuals in other disciplines will benefit from this course as well. (Prerequisites: HRDE-710 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

HRDE-732 Learning Transfer
Learning transfer is the ability of an organization to promote the individuals transfer of learning back to their job. This course examines the research conducted in this area and how it is applied in practice. As an HRD practitioner it is imperative that the impact of training, the transfer of knowledge, is built into the design of every program. By focusing on learning transfer, the goal of any program is to ensure that employees in the workplace are applying the newly acquired knowledge in the fulfillment of their job. This course examines the theoretical foundations of knowledge transfer, how to measure and evaluate this transfer and strategies for increasing the probability this transfer will occur. (Prerequisites: HRDE-710 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

HRDE-740 Strategic HRD for Global Organizations
Global Human Resource Development is a method for developing employees in global organizations. In this course, students will be exposed to the fundamentals of developing HRD programs within a multicultural framework. The need to be aware of cultural differences and how to best address them is critical for the global company. This course will explore globalization and HRD, design and development of global HRD programs, delivery and assessment of global HRD programs, and consulting across cultures. (Prerequisites: HRDE-710 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

HRDE-741 Global Human Resource Development Leadership
This course provides students with a theoretical foundation of global leadership. The frameworks presented in this course will help to guide students through a critical perspective of how they view leadership and how HRD can take part in developing leaders. Additionally, the global context of leadership will provide knowledge of the foundational concepts of leadership and how it impacts multinational organizations. Course focuses on Human Resource Development applications and problem solving and not on Human Resource Management. (Prerequisites: HRDE-710 or equivalent course.) Lecture, Credits 3 (Spring)

HRDE-742 Change Leadership Development
The goal of this course is to encourage students to carefully analyze their responsibilities and commitments in the context of leadership for change affecting the good of the organization. The course goes beyond the study of leadership; it will focus the student on developing the specific leadership skills for HRD they will need to effectively lead organizations through change to achieve their visions and goals. Most importantly, it will guide students through a self-awareness process that will highlight their change leadership characteristics and help to establish a plan of action to increase these competencies. Course focuses on Human Resource Development applications and problem solving and not on Human Resource Management. (Prerequisites: HRDE-710 or equivalent course.) Lecture, Credits 3 (Fall, Summer)

HRDE-750 Theories of Career Development
Theories of Career Development (TCD) introduces students to traditional and emerging career development theory and its application to workplace issues. Theories such as trait and factor, type, developmental, psychodynamic, work adjustment, life-span, social learning, and career decision-making are covered using a system theory approach. Additional topics include organizational career development, application of theory to modern problems and issues, and contemporary issues in career development. The course is participative and draws heavily on case studies, role-playing, self-assessment, and group work to understand the theory and workplace application issues. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Spring)

HRDE-752 Assessments and Measurements in Human Resource Development
This course provides and introduction to the fundamentals of assessment and measurement tools used in human resource and organizational development activities. An overview of a variety of instruments will be studied and some will be administered. Reading, lecture and class activities will include theory of test development, criteria for administration, validity, reliability, and assessing best instruments for use. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall)

HRDE-755 Program Assessment and Evaluation
A learning environment assessment of accomplishment of learning outcomes and the summative effect these have on forming professional and workforce competencies requires attention to assessment strategies and overall summative evaluation of the learning program outcomes and abilities to meet the needs of the learners and the organization. This course will consider how to measure performance for the variety of intellectual learner domains as well as the overall program effectiveness and interpretation of data collection efforts to test the efficacy of the learning outcomes. (Prerequisites: HRDE-715 or equivalent course.) Lecture, Credits 3 (Fall)

HRDE-756 Training Design
Given the organizational needs assessment results and the learners abilities training is often the solution used to enhance personal performance within an organization. A variety of strategies including non-traditional learning programs and tools, development of engaging learning programs linked to corporate strategies for promotion and succession and/or use of traditional instruction strategies to engage the learner in the task and enhance personal productivity will be explored, developed for situational. (Prerequisites: HRDE-715 or equivalent course.) Lecture, Credits 3 (Spring)

HRDE-758 Design for On-Line Learning
On-Line learning has grown to be a significant learning/teaching strategy for higher education. This course will include strategies for interactive learning activities to engage adult learner and achieve learning outcomes using a variety of instructional techniques appropriate for the on-line learning environment. This course will provide an opportunity to complete an actual work-related learning activity as an alternative to a case-based learning activity. (Prerequisites: HRDE-715 or equivalent course.) Lecture, Credits 3 (Spring)

HRDE-779 Special Topics
Special topics is an innovative course not reflected in the accepted curriculum. Once the outline is submitted titles will appear in the course listing for the semester. The course may be taken more than once as topics change. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring, Summer)

HRDE-794 Integrative Problem Solving
Students will demonstrate synthesis and integration of the theories and foundation principles of their discipline. This will be achieved through application of core knowledge in a series of progressive problem situations culminating in a comprehensive examination. Completion of all HRDE core and required courses required. Students must receive a passing grade of at least 80% in the course to be allowed to take the comprehensive exam. Lecture, Credits 3 (Fall, Summer)

HRDE-795 Comprehensive Examination
A written comprehensive exam is one of the non-thesis methodologies for completion of the MS degree. Students will demonstrate a fundamental knowledge of the theories and foundation principles. This course will include a review of the main concepts of each of the core subjects. Completion of all HRDE core and required courses required. Students must receive a passing grade of at least 80%to be successful. Students will have one additional opportunity to pass this examination if their initial attempt results in a failing grade. CMP, Credits 0 (Int, Su)

HRDE-797 Graduate Capstone Project
The purpose of this course is to provide students the opportunity to conduct research, develop a plan and evaluation components and submit the project as a demonstration of final proficiency in the program. The topic selected by the student will be guided by the faculty teaching the class and it will require the student to coalesce and incorporate into the final project a culmination of all their course work in the program to date. Lecture, Credits 3 (Fall, Spring, Summer)
HRDE-798 Research Thesis
A thesis is based on experimental evidence obtained by the candidate in an appropriate topic demonstrating the extension of theory into practice. A written proposal which is defended and authorized by the faculty advisor/committee followed by a formal written thesis and oral presentation of findings are required. Typically the candidate will have completed Research methods, Data analysis and Graduate writing strategies prior to enrolling in this course and will start the thesis process as soon as they have completed these courses to allow them to finish the thesis when they have finished their coursework. The candidate must obtain the approval of their Graduate advisor who will guide the thesis before registering for this course. Thesis, Credits 1 - 6 (Fall, Spring, Summer)

HRDE-799 Independent Study
This course provides for independent study or research activity in subject matter areas not included in any existing course in the degree program, but having specialized value to students. Proposals approved by a supervising faculty member and the program chairperson are required prior to registration. This course may be taken more than once. Independent Study, Credits 1 - 3 (Fall, Spring, Summer)

Manufacturing and Mechanical Engineering Technology

MCET-620 Robust Design and Production Systems
In this advanced course, students explore methods, such as Taguchi arrays, that support the optimization and verification phases of the Design for Six Sigma development process. Topics covered include the experimental design process, additivity, static and dynamic signal-to-noise ratios, analysis of means, and ANOVA. The role of robust design methods in reducing variability for both products and processes and in integrating systems is emphasized. (Graduate standing or permission of instructor) (This course is restricted to graduate or BS/MS students in the MMSI-MS, MFSI-MS, MCSI-MS and EMSI-MS programs.) Lecture, Credits 3 (Fall)

MCET-670 Concept Design and Critical Parameter Management
This course focuses on critical parameter management (CPM) as defined within the Design for Six Sigma framework. CPM tools and techniques include translating the voice of the customer into technical requirements, defining functions to fulfill the requirements, generating designs that physically fulfill the functions, data acquisition and analysis, and the evaluation and selection of superior product and subsystem designs that are safe to take to commercialization. Students are introduced to CPM best practices through case studies and hands-on projects. (This course is restricted to graduate or BS/MS students in the MMSI-MS, MFSI-MS, MCSI-MS and EMSI-MS programs.) Lecture, Credits 3 (Spring)

MCET-720 Product and Production System Development and Integration
This course covers topics, processes and best practices in product development. Using Design for Six Sigma (DFSS) as a motivating philosophy, students are introduced to concepts and techniques in the early stages of the product development process, including capturing the voice of the customer, critical parameter management, the phase-gate approach, and system integration for total product life cycle performance. The course provides an overview of DFSS goals, its development process, CDOV (Concept-Design-Optimize-Verify), and technology process IDOV, Innovate-Develop-Optimize-Verify, as well as strategies in product commercialization. (This course is restricted to graduate or BS/MS students in the MMSI-MS, MFSI-MS, MCSI-MS and EMSI-MS programs.) Lecture, Credits 3 (Fall)

MCET-650 Manufacturing and Mechanical Systems Fundamentals
This course is intended to help students learn to think like Systems Engineers. This course will provide a thorough understanding of the systems fundamentals, its design, modeling and integration. Topics include a thorough coverage of systems architecture, conceptualization, modeling, development and management. Students in this course will be taught industry practices for systems engineering and management from concept stage to post implementation stage. System engineering and modeling tools will also be introduced to assist with the conceptualization, development and implementation of systems. (This course is restricted to graduate or BS/MS students in the MMSI-MS, MFSI-MS, MCSI-MS and EMSI-MS programs.) Lecture, Credits 3 (Fall)

MCET-655 Electronics Packaging Fundamentals
This course provides a thorough understanding of the technology, components, equipment, design and manufacturing process for surface mount electronics manufacturing. Students will develop a strong foundation needed for advanced work in surface mount technology (SMT). The laboratory activities will provide the students an orientation and familiarization of the manufacturing equipment and process parameters for printed circuit board assembly. (This course is restricted to graduate or BS/MS students in the MMSI-MS, MFSI-MS, MCSI-MS and EMSI-MS programs.) Lecture, Recitation 1, Credits 3 (Fall)

MFET-670 Manufacturing Automation Control
This course will provide a thorough understanding of the manufacturing automation principles, practices and system integration. Topics include a thorough coverage of the automation hardware and software, essentials of digital and analog control using Programmable Logic Controllers (PLC’s), industry best practices for programming PLC’s and the essentials of Human Machine Interface (HMI) for data entry, manipulation and recording system status. (This course is restricted to graduate or BS/MS students in the MMSI-MS, MFSI-MS, MCSI-MS and EMSI-MS programs.) Lecture, Credits 3 (Fall, Spring)

MFET-685 Robots and CNC in Integrated Manufacturing
Technology and application of robots and CNC in an integrated manufacturing environment is the focus of this course. An introductory understanding of robotic hardware and software will be provided. The hardware portion of this course involves robot configurations, drive mechanisms, power systems (hydraulic, pneumatic and servo actuators), end-effectors, sensors and control systems. The software portion of this course involves the various methods of textual and lead through programming. Digital interfacing of robots with components such as programmable logic controllers, computer-controlled machines, conveyors, and numerical control will be introduced. Robotic cell design and the socio-economic impact of robotics will also be discussed. This course also has a strong laboratory component that emphasizes hands-on training. (Prerequisites: MCET-220 or equivalent course or graduate standing in MMSI-MS, MFSI-MS, MCSI-MS or EMSI-MS programs.) Lecture, Recitation 1, Credits 3 (Fall)

MFET-689 Special Topics in CAE
Subject offerings of new and developing areas of CAE knowledge in mechanical and manufacturing engineering technology intended to augment the existing curriculum. Special Topics courses are offered periodically. Lecture/Lab, Credits 3

MFET-756 Advanced Concepts in Electronics Packaging
This advanced course in electronics packaging will provide a thorough coverage of the materials, processes, failure and reliability of chip level and PCB level packaging. Specific topics include single-chip, multi-chip, wafer level and 3D stacked packaging, smaller passives and embedded passive component technology, advanced substrates and microvia technology, solder technologies, metallurgy and joint formation, thermal management, thermal and mechanical behavior of packaging, failure analysis and reliability testing. (Prerequisites: MFET-345 and MFET-346) or MFET-655 or equivalent course.) Lecture, Credits 3 (Spring)

MFET-778 MMSI Thesis Planning
Students will rigorously develop their thesis research ideas, conduct literature reviews, identify and plan methodologies, prepare schedules, and gain a clear understanding of the expectations of the faculty and the discipline. Each student will be required to prepare a committee approved thesis research proposal and may begin work on their thesis. (Enrollment in this course requires permission from the department offering the course.) Lecture, Credits 3 (Spring)

MFET-789 MFET Special Topics
Subject offerings of new and developing areas of knowledge in Manufacturing intended to augment the existing curriculum. Lecture, Credits 3 (Fall, Spring)

MFET-790 MMSI Thesis
The MMSI Thesis is based on thorough literature review and experimental substantiation of a problem, by the candidate, in an appropriate topic. A written proposal has to be defended and authorized by the faculty advisor/committee. The proposal defense is followed by experimental work, a formal written thesis and oral presentation of findings. The candidate should have completed the requisite courses for the program before enrolling for the thesis. (Prerequisites: MFET-788 or equivalent course.) Thesis, Credits 3 (Fall, Spring, Summer)

MFET-795 MSSI Comprehensive Exam
A written comprehensive exam is one of the non-thesis or non-project methodology for completion of the MS-MSSI degree. Students will demonstrate a fundamental knowledge of the theories and foundation principles. This course will require the student to do an independent review of the concepts within the core courses and the chosen concentration area, and will culminate in a comprehensive written examination. The student must receive a passing grade of at least 80% to be successful. Students will have one additional opportunity to pass the exam, if their initial attempt results in a failing grade. (Enrollment in this course requires permission from the department offering the course.) CMP, Credits 0 (Fall, Spring, Summer)

MFET-798 Continuation of Capstone
Continuation, Credits 0

Continuation of Capstone
Packaging Science

PACK-699 Graduate Co-op
Work experience in packaging science position appropriate to selected major in graduate program. Position to be obtained through interviewing process with the assistance of Cooperative Education and Career Services Office. Co-op, Credits 0

PACK-701 Research Methods
Discussion of the procedures, methods and requirements for carrying out the research project. Students pursue advanced study and research in the following areas: distribution packaging, package systems development, product and/or package damage in the transport environment, materials, quality preservation, sustainability, mechanical properties of packaging materials and systems. A research paper is required. Lecture, Credits 3 (Fall)

PACK-702 Graduate Writing Strategies
Taught in conjunction with Research Methods students will become articulate in a variety of business and research communication methodologies. These methods will include writing a research proposal, a white paper, and a grant proposal. A search of the literature for a defined research proposal will include an annotated bibliography to support the references used in the research proposal. In addition students will research the requirements for submission of a professional journal in their field and write a research article which could be submitted for publication to the identified journal. Lecture, Credits 3 (Fall, Spring)

PACK-730 Packaging and the Environment
Consideration of packaging in a social context. Factors that enhance secondary use, recycling, recovery of resources and proper disposal are discussed. Package design in relation to solid waste disposal and materials and energy shortages are considered. Other topics of interest are discussed. Primarily a discussion class for graduate students. Open to graduate non-majors. Lecture, Credits 3 (Spring)

PACK-742 Distribution Systems
The course develops knowledge and application skills of the distribution packaging. Topics covered are packaging used in distribution systems, integrated packaging supply chain, modeling and analysis of the distribution systems and score card in packaging supply chain. Emphases are given to estimate and predict the packaging protection and to optimize the packaging distribution using various tools. The lab focuses on development and evaluation of a distribution packaging. The projects are designed to assess the packaging performance in distribution systems. (This course is restricted to students in the PACK-MS program.) Lecture, Credits 3 (Spring)

PACK-750 Packaging Materials, Processes and Applications
This graduate level course is designed to present the theory, foundation principles and practices which form the basis of Packaging Science. Lecture 4, Credits 3 (Fall)

PACK-751 Advanced Packaging Design
The course develops knowledges of packaging design graphics and skills of package structure design. Topics covered are basics of engineering design graphics, technical sketch, project plan, design matrix, computer aided design (CAD) and rapid prototyping. Emphasis is given to use SolidWorks — CAD software to design typical packaging structures. The design project focuses on developing a packaging structure from an idea to an actual prototype. Lecture/ Lab 4, Credits 3 (Spring)

PACK-752 Advanced Computer Applications
The course develops knowledge and skills in applying two computer software packages for packaging design: Artios CAD and Adobe Illustrator. Topcis covered are model and rebuild, solid modeling and drawing, animation, coloring and painting. Emphasis is given to create a typical paperboard based carton with a proper structure and color usage. Lecture/ Lab 4, Credits 3 (Spring)

PACK-763 Packaging for End Use
An intensive study of package design requirements specific to use of a product at specified end points. Individual design and development of a package system and its specifications, appropriate to the needs of the product and the consumer/end user and meets the demands of the supply chain. (Prerequisites: PACK-451 or equivalent course or graduate student standing in the PACK-MS program.) Lecture 3, Credits 3 (Spring)

PACK-783 Advanced Packaging Dynamics
The study of instrumentation systems for analysis, evaluation and application of shock and vibration test methods to develop protective package designs and effective product/package interaction. A research paper is required. (This course is restricted to students in the PACK-MS program.) Lecture 3, Recitation 1, Credits 3 (Spring)

PACK-789 PS Special Topics
PS Special Topics Lecture, Credits 1 - 3 (Fall, Spring, Summer)
SERQ-720 Service Scenario and Strategy Development

The service world has many failures of large, once-successful companies that failed to accomplish the primary goal of every organization: consistently design and deliver value to consumers and other key stakeholder groups in a highly competitive and ever-changing service environment. This course introduces the concepts, principles, and practices necessary to avoid failure by taking an action-oriented approach to planning, implementing, evaluating, and revising competitive strategy in service firms. The course will address basic concepts and principles of competitive strategy, the process of developing and implementing strategy in service-centered firms, development of robust, future-oriented strategies using learning scenarios, strategy mapping, and tools for strategy evaluation such as performance metrics, scorecards and dashboards. (Prerequisites: SERQ-710 or equivalent course.) Lecture 3, Credits 3 (Fall, Spring, Summer)

SERQ-722 Customer Relationship Management/Customer Centricity

The Customer Centricity course allows the learner to manage within their organization interactions with valued customers across multiple channels, and provide options to maximize revenue, build foundations to increase customer experience/value and drive customer retention and commitment. The student will learn to identify strategies and implement beneficial relationships with customers by learning about service elements that are critical to consumers. (Prerequisites: SERQ-710 or equivalent course.) Lecture 3, Credits 3 (Fall, Spring)

SERQ-730 Project Management in NFP

Managing public sector projects is a complex, demanding process involving ethical considerations, leadership, the ability to understand complex rules and regulations, the politics of the administration and the vagaries of the budget process. This conceptual framework will address planning, selection of team members, contracts and agreements, monitoring and adjusting the project progress and completion of the project through turnkey stages. The end result of this process is to contribute to establishment of trust of the public, minimize failure and maximize success. (Prerequisites: SERQ-710 or equivalent course.) Lecture 3, Credits 3 (Fall, Summer)

SERQ-732 Service Quality in NFP

In the public sector, service satisfaction is a major contributor to the success or failure of public administration. To engage stakeholders, gain their trust and earn an appropriate appraisal of service quality requires strategies appropriate for dealing with the public sector as well as what is generally used to assess service quality. To enable better quality performance outcomes in the public sector, students will learn a dynamic quality system thinking and modeling strategy to establish a service system to maximize success, minimize failures and overall improve the quality of services provided to the public sector. The outcome of this course is enhance the learners ability to provide the highest level of stakeholders satisfaction possible for services rendered in the public sector. (Prerequisites: SERQ-710 or equivalent course.) Lecture 3, Credits 3 (Spring, Summer)

SERQ-735 Data Mining in NFP

To gather information and analyze the information to inform decisions is the goal of every public sector administration. This data can drive success of the government or lead to its downfall. This course will explore data mining used in the public sector, how to gather it and utilize the results of the data collections to inform decisions that reflect the needs and desires of the stakeholders in this sector. (Prerequisites: SERQ-710 or equivalent course.) Lecture 3, Credits 3 (Fall)

SERQ-740 Leadership Tools and Techniques

This course will allow students to be aware of and utilize tools and techniques to build and sustain leadership skills. The course approaches leadership development from a systems perspective examining and mastering proactive leadership approaches, understanding and using team building and team learning, examining various leadership techniques including, benchmarking, continuous improvement, six sigma and lean, gap analysis and more. Dialog and case analysis are used to enable all students to comprehend the myriad of tools available and be able to construct a stronger service organization. (Prerequisites: SERQ-710 or equivalent course.) Lecture 3, Credits 3 (Fall, Spring)

SERQ-750 The Student Experience in Higher Education

This course explores the “student experience” in higher education. Since students are, arguably, a university’s most important customer, how should institutions approach the student experience on and off campus? This course will prompt students to consider the wide range and types of colleges and universities around the world and the models used that form the college experience. These approaches impact student perceptions of the higher education university reputation, marketability, alumni giving, and retention. Topics for investigation include: (1) Campus facilities and “third places”; (2) Student services; (3) Student activities and athletics; (4) Teaching and learning; (5) Campus traditions; (6) Assessment strategies. (Prerequisites: SERQ-710 or equivalent course.) Lecture 3, Credits 3 (Fall, Spring)

SERQ-751 Critical Systems in Higher Education

Higher education is a vital societal component in American and global societies and must be accessible to citizens. This course examines current and historical perspectives of the critical systems in higher education to fund, manage risk, and adhere to lawful practices and lead. All of these systems affect students in areas of accessibility, value, customer service, and the higher education experience. Included is an exploration of how price, cost, and value shape what is provided and who attends college as well as reviewing current practices and events that continue to shape higher education. (Prerequisites: SERQ-710 or equivalent course.) Lecture 3, Credits 3 (Fall)

SERQ-755 Organization and Leadership in Higher Education

This course explores features of core functional areas of modern higher education. The course focuses on the administration of higher education institutions and includes: historical contexts for higher education, student experience; 3) academic and administrative issues; 4) infrastructural concerns, including planning, technology, and facilities management. This course uses a survey perspective of these areas to provide a foundation for understanding the dimensions found within higher education. Lecture 3, Credits 3 (Fall)

SERQ-760 Special Topics

Selected topics is an innovative course not reflected in the accepted curriculum. Once the outline is submitted titles will appear in the course listing for the semester. The course may be taken more than once as topics change. (This course is restricted to students in the SVCLED-M5 program.) Lecture 3, Credits 3 (Fall, Spring, Summer)

SERQ-790 Research Thesis

A thesis is based on experimental evidence obtained by the candidate in an appropriate topic demonstrating the extension of theory into practice. A written proposal which is defended and authorized by the faculty advisor/committee followed by a formal written thesis and oral presentation of findings are required. Typically the candidate will have completed Research methods, Data analysis and Graduate writing strategies prior to enrolling in this course and will start the thesis process by taking thesis planning as soon as they have completed the prerequisites to allow them to finish the thesis when they have finished their coursework. The candidate must obtain the approval of their Graduate advisor who will guide the thesis before registering for this course. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 6 (Fall, Spring, Summer)

SERQ-791 Continuation of Research Thesis

Continuation of Research Thesis (Enrollment in this course requires permission from the department offering the course.) Continuation, Credits 0

SERQ-794 Integrative Problem Solving

Students will demonstrate synthesis and integration of the theories and foundation principles of their discipline. This will be achieved through application of core knowledge in a series of progressive problem situations culminating in a comprehensive examination. To be successful students must receive a passing grade of at least 80% in the course. Students will have one additional opportunity to register for and pass the Integrative problems solving course if their initial attempt result in a failing grade. (No more than 12 semester hours of coursework remaining to complete the program; completion of all core courses in their program; be currently enrolled in the program; possess a program GPA of 3.0 or higher; No outstanding incomplete grades, nor can the student be on academic/disciplinary probation. (Enrollment in this course requires permission from the department offering the course.) Lecture 3, Credits 3 (Fall, Summer)

SERQ-795 Comprehensive Exam

Students will demonstrate synthesis and integration of the theories and foundation principles of their discipline to respond to questions found in the comprehensive examination. This demonstration will apply core knowledge to problem situations to be successful students must receive a passing grade of at least 80%. (12 semester hours or less of coursework remaining to complete the program; completion of all core courses in the discipline; currently enrolled in the program; possess a program GPA of 3.0 or higher; No outstanding incomplete grades; student cannot be on academic/disciplinary probation; For disciplines requiring Integrative problem solving successful completion of that course, (Enrollment in this course requires permission from the department offering the course.) Lecture, Credits 3 - 6 (Fall, Spring, Summer)

SERQ-797 Capstone Project

The purpose of this course is to provide students the opportunity to conduct research, develop a plan and evaluation components and submit the project as a demonstration of final proficiency in the program. The topic selected by the student will be guided by the faculty teaching the class and it will require the student to coalesce and incorporate into the final project a culmination of all their course work in the program to date. (Enrollment in this course requires permission from the department offering the course.) Lecture, Credits 3 - 4 (Fall, Spring, Summer)

SERQ-798 Continuation of Capstone Project

Continuation of Capstone Project (Enrollment in this course requires permission from the department offering the course.) Continuation, Credits 0 (Fall, Spring, Summer)
TCET-661 Telecommunications Systems
The fundamental principles that govern the communication of information are introduced. At the end of this course, students will understand signal spectral analysis and the principles of digital and analog modulation formats. Topics in the course are spectral analysis techniques, modulation schemes, and noise and bit error rates. (This course is restricted to students in the TCET-MS program.) Lecture, Credits 3 (Fall)

TCET-699 TCET Graduate Co-op
Co-op, Credits 0 (Fall, Spring, Summer)

TCET-710 Principles of Telecommunications Networks
The course provides the student with a solid understanding of local access and backbone network, architecture, equipment and technology related to the Public Switched Telephone (PSTN), Cable (MSO), Access and Converged/IP networks. Passive Optical Networking and Hybrid Fiber Coax technology is also covered. (This course is restricted to students in the TCET-MS program.) Lecture, Credits 3 (Fall)

TCET-720 Telecommunications Concepts
The course provides the student with a solid understanding of Digital and Time Division Multiplexing and Modulation schemes used in the transmission of information in a variety of networks, both packet and circuit switched. Traffic engineering and Quality of Service concepts are covered as well as a number of network protocols and signaling platforms such as MPLS and SIP. (This course is restricted to students in the TCET-MS program.) Lecture, Credits 3 (Spring)

TCET-723 Telecommunications Network Engineering
This course covers accepted network design principles and methodologies as they apply to circuit, packet, frame, cell and synchronization networks. Course topics are transmission engineering, traffic engineering models, timing and synchronization, design of voice and data networks, and electrical grounding concepts. (Prerequisites: TCET-710 and TCET-720 or equivalent courses.TCET-710 & TCET-720) Lecture, Credits 3 (Fall)

TCET-730 Telecommunications Policy and Issues
The objective of this course is to enlighten students relative to telecommunications policy and standards sufficiently, in order for them to be able to deal with the real-world issues that confront telecommunications professionals on a daily basis. Students will not be prepared to act as regulatory experts or to replace specialized experts with legal training, but should be sufficiently cognizant of pertinent issues to know when it is prudent to call in such forces. The domestic as well as the international regulatory, policy and standard arenas will be explored. This course helps students to understand that the telecommunications environment is greatly affected by technology, policy, security and market forces with a primary focus on telecommunications policy and all that it entails. (This course is restricted to students in the TCET-MS program.) Lecture, Credits 3 (Fall)

TCET-740 Fiber Optic Telecommunications Technology
This course presents the basics of fiber-optic telecommunication systems including optical fiber, light sources and modulators, photodiodes and receivers, optical amplifiers, and passive components such as dispersion compensators, optical multiplexers and demultiplexers, and couplers. Fundamental concepts as well as state-of-the-art advances in these technologies will be covered. (This course is restricted to students in the TCET-MS program.) Lecture, Credits 2 (Fall)

TCET-741 Fiber Optic Telecommunications Technology Lab
This course provides extensive hands-on experience with basic technologies of fiber-optic telecommunication systems including optical fiber, light sources, and photodiodes, and key diagnostics such as optical time-domain reflectometers and optical spectrum analyzers. Students will measure the fiber impairments of dispersion and attenuation, and train in laser safety, fiber connector inspection, and fusion splicing. (MSTET accepted student or permission of instructor) (Co-requisite: TCET-740 or equivalent course.) Lab 2, Credits 1 (Fall)

TCET-745 Fiber optic Telecom Networks
This course focuses on characterizing and designing the capacity and reach of fiber-optic transmission systems in terms of key performance metrics (BER, Q-factor, eye diagrams, and system margin, transmission penalty, optical-power budgets, and OSNR budgets), the impact of key physical impairments (loss, dispersion, nonlinearity), and techniques used to overcome these impairments (optical amplification, dispersion compensation, power mitigation). Widespread fiber-optic transmission modalities (such as wavelength-division multiplexing and amplitude modulation) as well as emerging modalities (such as polarization-division multiplexing and phase modulation) will be covered. (TCET-745) Lecture 3, Credits 3 (Spring)

TCET-747 Next Generation Networks
This hybrid course is a cross between an independent study and a seminar course. It provides MSTET students the opportunity to research and report on near term “Next Generation Networks” (NGN). The course consists of professor provided discussion on NGN followed by each student researching NGN types. Basicallly, a case study approach is utilized. Immediately after completing the research and written paper regarding one’s selected topic/case, each student will read each others and then present theirs to all other students in the class. As a result, every student will not only benefit from their own research of topics/cases but also be informed of other NGN by other students. Students should already have some understanding of how to perform research and must possess at least adequate writing skills. (This course is restricted to students in the TCET-MS program.) Lecture 3, Credits 3 (Fall)

TCET-750 Wireless Infrastructure and Policy
The fundamental principles of and U.S. regulatory requirements for wireless mobile and fixed radio frequency communication systems are studied in this course. At the end of this course, students will understand the radio frequency mobile wireless environment, the common wireless systems, and the regulatory aspects related to deployment of the wireless infrastructure. (This course is restricted to students in the TCET-MS program.) Lecture, Credits 3 (Spring)

TCET-755 Wireless Communications Techniques
This course focuses on techniques for data transmission over the wireless channel. Students who take this course will start by learning about digital communications over the noisy channel, including how to model, simulate, and evaluate the system’s performance. Then, they will move on to the wireless channel, which presents a new set of challenges, such as multipath fading. Students will learn techniques to achieve reliable, efficient communication over this channel, such as coding, diversity, and MIMO. Students will be assigned exercises where they’ll use a computer and a software-defined radio to simulate, design and evaluate their own communications systems. (Prerequisites: TCET-750 or equivalent course.) Lecture, Credits 3 (Spring)

TCET-760 Network Planning and Design
This course teaches the art and science of metropolitan and wide area network design for both modern delay (data) networks and traditional blocking (voice) networks; the greatest emphasis is on modern delay networks. Both qualitative and quantitative approaches are used as the student progresses through the network analysis, architecture and network design processes. An advanced WAN Fiber Optic design tool, such as OPNET Transport Planner is utilized in a required graduate project. The following are typical projects: Write an RFP, design an extensive metropolitan and wide area network using the latest technologies, design an extensive fiber optic network using a design tool like OPNET Transport Planner. Note: Since some students may not yet have taken a fiber course, the OPNET project stresses the use of the tool rather than the specifics of fiber optics. (This course is restricted to students in the TCET-MS program.) Lecture, Credits 3 (Spring)

TCET-789 Special Topics in MSTET
Subject offerings of new and developing areas of knowledge in telecommunications engineering technology intended to augment the existing curriculum. Special Topics courses are offered periodically. Watch for titles in the course listing each semester. Lecture 3, Credits 1 - 3 (Fall, Spring)

TCET-790 Graduate Thesis
The MSTET graduate thesis is a document that describes and presents the results of scholarly research in the field of telecommunications. The results of a MSTET graduate thesis provide new knowledge, processes, software or other assets that advance the state of the art of telecommunications, even in a modest way. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 6 (Fall, Spring, Summer)

TCET-797 Graduate Project
The MSTET graduate project describes and presents the results of scholarly research in the field of telecommunications. The results of a MSTET graduate project provide new knowledge, processes, software or other assets that advance the state of the art of telecommunications or organize or implement existing knowledge in a unique and useful way. (Enrollment in this course requires permission from the department offering the course.) Project, Credits 1 - 6 (Fall, Spring, Summer)

TCET-899 Graduate Independent Study
Study or laboratory work on a topic in or related to telecommunications engineering technology. (This course requires permission of the Instructor to enroll.) Independent Study, Credits 1 - 4 (Fall, Spring)
Graduate Writing and Research Courses

GRCS-701 Research Methods
This is an introductory graduate-level survey course on research design/methods and analysis. The course provides a broad overview of the process and practices of research in applied contexts. Content includes principles and techniques of research design, sampling, data collection, and analysis including the nature of evidence, types of research, defining research questions, sampling techniques, data collection, data analysis, issues concerning human subjects and research ethics, and challenges associated with conducting research in real-world contexts. The analysis component of the course provides an understanding of statistical methodology used to collect and interpret data found in research as well as how to read and interpret data collection instruments. CAST and HLTH graduate students only. Dept. approval. Lecture 3, Credits 3 (Fall, Spring)

GRCS-702 Graduate Writing Strategies
Students will demonstrate written communication skills applied to research and outcome methods. These methods include knowledge of the use of data bases for research of a specified topic, use of appropriate references and citations, a written research proposal, a white paper, and a grant proposal. A search of the literature for a defined research topic, which includes an annotated bibliography to support the references used and a summary document for the results of the literature search. In addition students will critique professional journals in their field and write a summary analysis of these articles. Lecture 3, Credits 3 (Fall, Spring)
### Saunders College of Business

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Course numbering: RIT courses are generally referred to by their alphanumeric registration label. The four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100-299), upper division (300-599), or graduate level (600 and above).

Unless otherwise noted, the following courses are offered annually. Specific times and dates can be found in each semester's schedule of courses. Prerequisites/corequisites are noted in parentheses near the end of the course description.

### Accounting

**ACCT-605** Accounting Profession
- This course consists of a series of workshops designed to introduce accounting and other interested graduate business students to the skills needed to be successful in job and co-op searches and the transition into professional life and careers. Students will establish their career goals, create material (e.g., resume, cover letter), and acquire skills needed to achieve these goals. Students will be expected to interact with business professionals, and study materials related to current and emerging trends in accounting and business. Active class participation is required. (GRAD-SCB) Lecture, Credits 3 (Fall)

**ACCT-645** Accounting Information Systems
- This course combines information systems concepts and accounting issues. In this course, we discuss the conceptual foundations of information systems, their applications, the control and auditing of accounting information systems, and the system development process. Topics include the business process, e-business, relational database, database design, computer fraud and security, accounting cycle, system analysis and AIS development strategies. Students analyze accounting information systems topics through problem solving, group projects, presentations, exams, and case studies. (Prerequisites: ACCT-603 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

**ACCT-704** Corporate Financial Reporting I
- A comprehensive exposure at an intermediate level to financial accounting theory and practice under U.S. Generally Accepted Accounting Principles. Emphasis is placed on applying underlying accounting theory to complex accounting and reporting problems. The effects of alternative accounting methods are considered. International Financial Reporting Standards are introduced as they relate to course subject matter. (Prerequisites: ACCT-603 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

**ACCT-705** Corporate Financial Reporting II
- Continuation of Corporate Continuation of Corporate Financial Reporting I with emphasis on equity and special measurement and reporting problems. Topics include liabilities and contingencies, stockholders' equity, earnings per share, pensions, leases, revenue recognition, income tax accounting, and the statement of cash flows. International Financial Reporting Standards are introduced as they relate to course subject matter. (Prerequisites: ACCT-704 or equivalent course.) Lecture, Credits 3 (Fall)

**ACCT-706** Cost Management
- The development and use of cost data for external reporting and internal cost management (planning and control). Topics include job costing, process costing, joint product costing, cost reassignments, standard costs, activity-based costing, decentralization and transfer pricing, and cost variances. Consideration is given to manufacturing, service and retail organizations. (Prerequisites: ACCT-603 or equivalent course.) Lecture, Credits 3 (Spring)

**ACCT-707** Advanced Accounting
- Study of the application of generally accepted accounting principles and international financial reporting standards to business enterprises, including corporations with investments in subsidiaries, domestic and international, and partnerships. Issues involving consolidated financial statements, including international topics, are considered. Also examined are objectives for not-for-profit and governmental entities, and how these objectives affect their financial accounting and reporting. (Prerequisites: ACCT-705 or equivalent course.) Lecture, Credits 3 (Spring)

**ACCT-708** Auditing and Professional Responsibility
- A study of the legal, ethical, and technical environment in which the auditor works. Current auditing theory, standards, procedures, and techniques are studied. The audit process is studied to ascertain how it leads to the development of an audit opinion. (Prerequisites: ACCT-704 or equivalent course.) Lecture, Credits 3 (Spring)

**ACCT-709** Basic Taxation
- A basic introductory course in federal income taxation. Emphasis is on taxation of individuals and sole proprietorships. Topics include income measurement and deductibility of personal and business expenses. (Prerequisites: ACCT-603 or equivalent course.) Lecture, Credits 3 (Spring, Summer)

**ACCT-710** Advanced Taxation
- A continuation of Basic Taxation. Emphasis is on tax treatment of property transactions and taxation of businesses entities. Also covers the use of technology to prepare complex returns and to research tax issues. (Prerequisites: ACCT-709 or equivalent course.) Lecture, Credits 3 (Fall)

**ACCT-711** Internal Auditing
- Course explores the role of the internal audit function in the management of companies. Topics include internal vs. external auditing, internal control issues, reliability and integrity of information; compliance with policies, procedures, laws and regulations; efficiency of operations. Ethical considerations affecting the internal audit function are introduced. (Prerequisites: ACCT-603 or equivalent course.) Lecture, Credits 3 (Fall)

**ACCT-738** Information Systems Auditing and Assurance Services
- An examination of the unique risks, controls, and assurance services resulting from and related to auditing financial information systems with an emphasis on enterprise resource systems. (Prerequisites: ACCT-705 or equivalent course. Pre- or Corequisites: ACCT-708 or equivalent course.) Lecture, Credits 3 (Spring)

**ACCT-740** Financial Statement Analysis
- This course is designed to prepare students to interpret and analyze financial statements effectively. Explores in greater depth some of the financial reporting topics introduced in the core accounting course and includes a discussion of International Financial Reporting Standards. (Prerequisites: ACCT-603 and FINC-721 or equivalent courses.) Lecture, Credits 3 (Fall)

**ACCT-741** Cases in Forensic and Fraud Examination
- Overview of the nature of occupational fraud and how it is committed including an introduction to the actions that can be taken to determine the presence of occupational fraud and procedures that can be implemented to deter fraud. Also covered is the proper manner in which allegations of fraud should be investigated and documented and meet the requirements of civil/criminal court procedure. Course is principally taught through case study. (Prerequisites: ACCT-603 or equivalent course.) Lecture, Credits 3

**ACCT-758** Seminar in Accounting
- Special topics seminars offer an in-depth examination of current events, issues and problems unique to accounting. Specific topics will vary depending upon student and faculty interest and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. These seminars may be repeated for credit since topics normally vary from semester to semester. (Depends on topic) Lecture, Credits 3

**ACCT-790** Field Exam Prep
- All MS-Accounting students will take a field exam at the end of their program. This course provides basic help to students taking this exam. Note: all required courses in the MS-Accounting program. (ACCT-MBA or ACCT-MS) CMP 15, Credits 0 (Fall, Spring, Summer)

**ACCT-794** Cost Management in Technical Organizations
- A first course in accounting for students in technical disciplines. Topics include the distinction between external and internal accounting, cost behavior, product costing, profitability analysis, performance evaluation, capital budgeting, and transfer pricing. Emphasis is on issues encountered in technology intensive manufacturing organizations. *Note: This course is not intended for Saunders College of Business students. (Enrollment in this course requires permission from the department offering the course.) Lecture, Credits 3 (Spring)
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ACCT-795  Financial Accounting Theory and Research
This course examines the theoretical concepts, definitions, and models espoused in the accounting literature and relevant to analyzing contemporary issues in financial accounting and reporting. It also considers the historical development of accounting standards, contemporary issues in financial reporting including international standards, and research methods used to determine the appropriate methods to comply with accounting standards. Course requires writing and student presentations. (Prerequisites: ACCT-705 or equivalent course.) Lecture, Credits 3 (Spring)

ACCT-799  Independent Study Accounting
The student will work independently under the supervision of a faculty advisor. (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 3 (Fall, Spring, Summer)

ACCT-802  Managerial Accounting
Managerial Accounting emphasizes identifying and applying the techniques used by managerial accountants to measure the cost of goods and services produced by the firm. The course focuses on understanding how managerial accounting is used to help organizations achieve their goals. (Prerequisites: ACCT-801 or equivalent course.) Lecture, Credits 2 (Fall)

Business Legal Studies

BLEG-612  Legal and Accounting Issues for New Ventures
An introduction to basic legal and accounting issues that managers and developers of new business ventures must understand at the outset. Topics include financial statements prepared using both the cash basis and GAAP, differences among basic legal forms of business organization and related income tax issues, budgeting and cash flow management, and product costing. The focus is on understanding the legal and accounting components of the business plan. Lecture, Credits 3 (Spring)

BLEG-730  Business Legal Concepts
An introduction to legal principles and their relationship to business organizations. Explores the U.S. legal system, the U.S. court system, civil and criminal procedure, the role of government agencies, legal research, and the substantive areas of law most relevant to business, including constitutional law, tort law, criminal law, contract law, intellectual property, debtor-creditor relations, bankruptcy, business entities, securities regulation and antitrust law. Extensive legal research projects are an essential part of the course. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Spring)

BLEG-745  Legal and Ethical Issues in Technology-intensive Environments
The course confronts graduate students with a wide variety of legal and ethical issues in organizational environments that are technologically intensive, such as information technology and the life sciences. Impacts of intellectual property legislation and legal cases in national and international venues are investigated. Legal and social issues involving individual privacy are argued. This exposure to legal and ethical dilemmas is an important tool as the graduates encounter situations throughout their careers. Coupled with technical proficiency, the ability to deal with legal and ethical issues shapes professional successes and failures. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring)

BLEG-758  Seminar in Business Legal Studies
Special topics seminars offer an in-depth examination of current events, issues and problems unique to Business Legal Studies. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from semester to semester. Lecture, Credits 3

Decision Sciences

DECS-743  Operations and Supply Chain Management
Study of the management of operations and supply chain management. Encompasses both manufacturing and services. Topics include operations and supply chain strategy, ethical behavior, forecasting; work systems, inventory management, capacity and materials planning, lean operation, supply chain design and closed-loop supply chains, global operations, quality management, quality control, and quality improvement, project management; and current issues. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring, Summer)

DECS-744  Project Management
A study in the principles of project management and the application of various tools and techniques for project planning and control. This course focuses on the leadership role of the project manager, and the roles and responsibilities of the team members. Considerable emphasis is placed on statements of work and work breakdown structures. The course uses a combination of lecture/discussion, group exercises, and case studies. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring)

DECS-745  Quality Control and Improvement
Study of total quality management (TQM), including Deming’s philosophy, Six Sigma; quality planning, quality cost principles, problem-solving methods and tools, the use of statistical methods for quality control and improvement, supplier relations, and recent developments in quality. The course focus is on the management and continuous improvement of quality and efficiency in manufacturing and service organizations. (Prerequisites: DECS-782 or equivalent course.) Lecture, Credits 3 (Spring)

DECS-758  Seminar in Decision Sciences
Special topics seminars offer an in-depth examination of current events, issues and problems unique to Decision Science. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from semester to semester. (Instructor-determined) Lecture, Credits 3

DECS-782  Statistical Analysis for Decision Making
This is a course in applied statistics emphasizing an understanding of variation and inference (estimation and testing). Topics to be covered include: review of descriptive statistics, normal distribution, sampling distributions, estimation, test of hypothesis for single and two populations, analysis of variance (ANOVA), linear regression, multiple regression and model building. Students will apply these concepts using mini-cases and problem sets that involve both structured and unstructured data sets. The application of appropriate tools will be required. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring, Summer)

DECS-799  Independent Study Decision Sciences
The student will work independently under the supervision of a faculty advisor. (Instructor approval) (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 3 (Fall, Spring, Summer)

DECS-810  Statistical Analysis for Managers
This course introduces concepts for interpreting and analyzing data as a tool for assisting managers in making complex business decisions. Topics to be covered include: review of descriptive statistics, normal distribution, sampling distributions, estimation, test of hypothesis for single and two populations, linear regression, multiple regression and model building. The application of appropriate statistical tools will be required. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 2 (Fall)

DECS-864  Systems Support for Operations
This course focuses on the application of information technology to gain greater efficiency and effectiveness from operational and managerial processses and systems. The conceptual foundations of operations, supply chain management and information technology are surveyed and contemporary approaches analyzed from a managerial perspective. Lecture, Credits 2 (Summer)

Economics

ECON-705  Economics and Decision Modeling
The course focuses on the fundamental economic theories most useful for the management of a firm in a global environment. Microeconomic theories and current events are used to explain the performance of the market system and help managers formulate effective pricing and business decisions. Macroeconomic theories and current events are used to explain the direction of the domestic and global economy to help managers understand the implications, including foreign direct investment, for their companies. Students will learn to explain and predict changes in economic growth, inflation, interest rates, international trade and foreign exchange rates. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring, Summer)

ECON-780  Advanced Microeconomic Theory
This course is designed for students planning graduate study in economics and for those who have a substantial background in microeconomic theory. Topics include general equilibrium and market anomalies, utility and risk, consumer behavior, production and the product market, factor proportions and factor mobility, imperfect competition, and applications of microeconomic theory in public policy. (Instructor-determined) Lecture, Credits 3

ECON-791  Microeconomic Theory
This is a course in applied microeconomic theory that focuses on the study of supply and demand analysis. It also covers topics in industrial organization and the theory of the firm. Prerequisites: ECON-780 or equivalent course. Lecture, Credits 3 (Fall, Spring, Summer)

ECON-801  Advanced Macroeconomic Theory
This course is designed for students planning graduate study in economics and for those who have a substantial background in macroeconomic theory. Topics include the history and contemporary challenges of the macroeconomy, money and banking, the choice of economic policy, inflation and unemployment, and growth. (Instructor-determined) Lecture, Credits 3

ECON-811  Macroeconomic Theory
This course is an intermediate-level course in macroeconomics designed for undergraduate, graduate and professional students. It covers a broad spectrum of topics, including the history of economic thought, the microeconomic foundations of the macroeconomic theory, the mechanics of the open economy, and the policy implications of macroeconomic theory. (Prerequisites: ECON-780 or equivalent course.) Lecture, Credits 3 (Fall, Spring, Summer)

ECON-821  Advanced International Finance
This course is designed for students planning graduate study in economics and for those who have a substantial background in international finance. It is a required course for Ph.D. students in the financial economics concentration. Topics include exchange rate determination, foreign exchange markets, foreign exchange crises, international capital markets, and international monetary policy. (Instructor-determined) Lecture, Credits 3

ECON-822  International Financial Management
This course is designed for students planning graduate study in economics and for those who have a substantial background in international financial management. It is a required course for Ph.D. students in the financial economics concentration. Topics include multinational corporations, international capital markets, international trade, financial risk management, cross-border investments, and international monetary policy. (Instructor-determined) Lecture, Credits 3

ECON-831  Advanced Applied Economics
This course is designed for students planning graduate study in economics and for those who have a substantial background in applied economics. Topics include econometric theory, statistical inference, and applications of econometrics to economic problems. (Instructor-determined) Lecture, Credits 3

12 Graduate Course Descriptions
ESCB-711 Microeconomics
Microeconomics introduces the principles of economic analysis as applied to micro decisions to determine how an organization can achieve its aims most efficiently. This course applies statistical and quantitative tools and the methodological approaches commonly used by economists to business problems as demand estimation, product pricing, profit maximizing level of output, cost minimizing level of input use, and forecasting. (ESCB-705 or two previous economics courses, one in microeconomics and one in macroeconomics with a grade of B or better.) (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Spring)

FINC-772 Financial Management II
This advanced course in corporate finance focuses on financing policies, financial planning/ control, and other advanced corporate topics. Specific topics include the financing process, alternative financing instruments, restructuring, cost of capital, corporate applications involving options, working capital management and the use of financial budgets/forecasts. (Prerequisites: FINC-721 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

FINC-725 Securities and Investment Analysis
A survey of topics in investment analysis, including the study of financial markets, features of various financial assets and security pricing. Focus is on individual security analysis (as distinct from portfolio analysis). Asset pricing theory is used in valuing securities. Practical issues in equity valuation are discussed including risk evaluation, macroeconomic/industry/competitive analysis and the use of corporate SEC filings. (Prerequisites: FINC-721 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

FINC-732 Portfolio Management
This course extends the knowledge of risk and return in a portfolio context to portfolio management. Topics include portfolio optimization, diversification strategies, hedging strategies and performance evaluation. A variety of investment tools (e.g., fixed income securities) and investment contexts (e.g., pensions) will be studied. (Prerequisites: FINC-725 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

ESCB-758 Seminar in Economics
Special topics seminars offer an in-depth examination of current events, issues and problems unique to economics. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from semester to semester. (Instructor determined) Lecture, Credits 3 (Fall, Spring)

ESCB-799 Independent Study Economics
The student will work independently under the supervision of a faculty advisor. *Note: Instructor approval (This course requires permission of the Instructor to enroll.) Independent Study, Credits 3 (Fall, Spring, Summer)

ESCB-840 Microeconomics and Pricing
This course introduces microeconomic concepts and how they can be employed to examine business decisions such as pricing under conditions of uncertainty. Models and applications are employed that describe the efficient allocation of resources within a firm. Topics include supply and demand, consumer behavior, production, cost and pricing. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 2 (Fall)

ESCB-841 Macroeconomics
Fundamental macroeconomic theories will be examined to explain and predict changes in economic growth, employment, inflation, consumer spending, business investment, and foreign trade. Financial markets, domestic and foreign, will be examined to understand changes in interest rates and exchange rates. The likely affects of government spending, taxes, and Federal Reserve Bank policies on the economy and business will be evaluated. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 2 (Fall)

Finance

FINC-605 Financing New Ventures
A focus on financial issues affecting an entrepreneur. The course emphasizes, identifies and follows the wealth creation cycle. The wealth creation cycle begins with an idea for a good, product or service, progresses to an initial company startup, passes through successive stages of growth, considers alternative approaches to resource financing, and ends with harvesting the wealth created through an initial public offering, merger or sale. Identification and valuation of business opportunities, how and from whom entrepreneurs raise funds, how financial contracts are structured to both manage risk and align incentives, and alternative approaches by which entrepreneurs identify exit strategies are reviewed. Lecture, Credits 3 (Fall)

FINC-671 Survey of Finance
This course introduces students to the field of finance and prepares them to undertake a study of advanced topics in other courses. Students learn about financial markets, regulation, and the fundamentals of corporate finance in areas such as investment and financing decisions. A brief overview of financial reporting allowing students to understand firm performance is also provided. (Prerequisites: ACCT-603 or equivalent course.) Lecture 45, Credits 3 (Fall)

FINC-721 Financial Analysis for Managers
An examination of basic financial theories, techniques, and practices. Topics include: time value of money, valuation, capital asset pricing, risk and diversification, cost of capital, capital budgeting techniques and spreadsheet analysis. (Prerequisites: ACCT-603 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

FINC-773 Debt Analysis
Students learn about various debt markets, trading, and valuation. The focus of this course is on valuing debt instruments using widely used methods and in forming and analyzing debt portfolios. (Prerequisites: FINC-671 or equivalent course.) Lecture 45, Credits 3 (Spring)
FINC-774 Advanced Derivatives
Students learn about derivatives contracts, their pricing, and uses. The course will cover advanced financial engineering topics such as the engineering of fixed-income contracts, volatility positions, credit default swaps, and structured products. (Prerequisites: FINC-671 and MATH-736 or equivalent courses.) Lecture, Credits 3 (Spring)

FINC-790 Field Exam Preparatory
All MS-Finance students take a field exam at the end of their program. This course provides basic help to students taking this exam. (all required finance courses in the MS-finance program) CMP, Credits 1 (Fall, Spring, Summer)

FINC-795 Computational Finance Experience
Students apply their mathematical, data analytic, and integrative finance skills in a complex project involving real or simulated data. Under the supervision of an advisor, students work in teams to perform a stipulated task/project and write a comprehensive report at the end of the experience. Subject to approval by the Program Director, an individual student internship/coop followed by an in-depth report may obtain equivalent credit. Lecture 3, Credits 3 (Summer)

FINC-799 Independent Study Finance
The student will work independently under the supervision of a faculty advisor. (Instructor approval) (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 3 (Fall, Spring, Summer)

FINC-845 Valuation and Capital Budgeting
The course introduces financial concepts of risk, return and valuation. The main application studied in this course, Capital Budgeting, arises in the corporate setting where managers allocate scarce resources to projects. Basic issues of capital budgeting covered include cash flow estimation and evaluation techniques. Advanced issues include sensitivity analysis and the consideration of real options. (Prerequisites: ACCT-802 or equivalent course. Corequisites: DECS-810 or equivalent course.) Lecture, Credits 2 (Spring)

FINC-846 Financial Planning and Analysis
This is the second-part of a two-course corporate finance sequence for EMBA students. The overall theme is one of strategic control of corporate assets and liabilities. The five topics covered in this course are: (a) long-term financial planning, corporate financing and cost of capital (b) short-term financial planning and the analysis of short-term assets and liabilities (c) risk management and the corporate use of derivatives (d) the analysis of international activities (e) corporate control activities. Three topics are explored in depth: short-term financial management, capital structure and dividend policy, and risk and hedging. Short-term financial management includes the topics of credit analysis, financial forecasting and planning, working capital management and cash flow management. (Prerequisites: FINC-845 or equivalent course.) Lecture, Credits 2 (Spring)

FINC-850 International Finance
This course examines how the international environment affects the practice of corporate finance by using a combination of theory and cases. Topics include an examination of the international environment the firm operates in, international investment, exchange rates and the management of risks arising from shifting exchange rates, and the problems of short and long-term asset and liability management. (Prerequisites: FINC-846 or equivalent course.) Lecture, Credits 2 (Fall)

International Business

INTB-710 Global Business Opportunities and Threats
This course is designed to keep students informed of the current trends of global business, develop students with the necessary theoretical foundations and analytical skills to compete in the global environment, and equip students with the knowledge base to take advantage of global opportunities and avoid risks in international business. Subject areas include how to discover opportunities and analyze risks in international trade, foreign investment, foreign exchange, and regional integrations. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring)

INTB-730 Cross-Cultural Management
An analysis of comparative global business behavior and organization with particular emphasis on values, authority, individual and group relations, labor-management ties, risk tolerance, and motivational techniques. The course will prepare students to recognize different values and cultural factors in the global business community and how these shape and determine appropriate management behavior. The problems and opportunities of transferring management practices from one culture to another will also be examined. (Prerequisites: MGMT-740 or equivalent course.) Lecture, Credits 3

INTB-750 Global Marketing Management
A managerial-focused course that examines global marketing from a strategic perspective. This course provides a framework for identifying and analyzing the cultural and environmental differences of countries and regions that impact global marketing. Students will evaluate opportunities and challenges in global markets to develop appropriate marketing programs and market-entry strategies. Topics include foreign market opportunity assessment, commercialization and entry strategy development, customer analysis, distribution channels, and promotion in global markets. (Prerequisites: MKTG-761 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

INTB-758 Seminar in Global Business
This course offers an in-depth analysis of the global institutional environment and provides students the opportunity to research a variety of global business issues, such as regional business studies, emerging markets, and global industry analysis. Specific topics will vary depending upon student and faculty interest and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. (Instructor determined) (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Spring)

INTB-780 Global Issues and Strategies
This course will focus on contemporary international and global business issues, such as governance, outsourcing and offshoring, role of non-governmental organizations (NGOs), etc. It will emphasize faculty-directed student research projects. (Prerequisites: INTB-710 or equivalent course.) Lecture, Credits 3 (Spring)

INTB-799 Independent Study - International Business
The student will work independently under the supervision of a faculty advisor. "Note: Instructor approval. (This course requires permission of the Instructor to enroll.) Independent Study, Credits 3 (Fall, Spring, Summer)

INTB-820 International Business
The primary objective of the course is to examine the strategies, concepts, theories, and practices associated with conducting international business. It seeks to develop practical and theoretical problem solving skills needed in the global business environment. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 2 (Fall)

INTB-825 International Study Seminar
This international study tour is an integral part of semester long focus on the strategic and operational issues facing organizations in a global competitive environment. Students will engage in lectures, plant visits, and interviews with international corporate managers. Students will apply the insights gained from their previous and concurrent coursework. This seminar offers students an inside view of individual companies and industries, and some of the broader economic, political, social, and cultural factors that influence business opportunities and practices in a particular region of the world. (Corequisites: INTB-820 or equivalent course.) Lecture, Credits 2 (Fall)

Management

MGMT-699 Honors Co-op
One semester of paid MBA related work experience. Lecture, Credits 0 (Fall, Spring, Summer)

MGMT-720 Entrepreneurship and New Venture Creation
This course studies the process of creating new ventures with an emphasis on understanding the role of the entrepreneur in identifying opportunities, seeking capital and other resources, and managing the formation and growth of a new venture. Lecture, Credits 3 (Fall, Spring, Summer)

MGMT-735 Management of Innovation in Products and Services
This course addresses the management of innovation, sustainable technology, and the importance of technology-based innovation for the growth of the global products and services industries. The course integrates three major themes: (1) leading-edge concepts in innovation, (2) the role of technology in creating global competitive advantage in both product-based and services-based industries, and (3) the responsibility of businesses related to sustainability. The importance of digital technology as an enabling of innovative services is covered throughout the course. (completion of four graduate business courses) Lecture, Credits 3 (Fall, Spring)
MGMT-741 Managing Organizational Change
This course addresses the importance of organizational change in maintaining a flexible, dynamic, and responsive organization, by examining various theories and approaches currently used to assist organizations in achieving planned change. The role of the leader in achieving organizational change is emphasized. The features of successful change in organizations will be discussed, including the structural, motivational, interpersonal, and social aspects of organizational change. (Prerequisites: MGMT-740 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

MGMT-742 Technology Management
This course is an introduction to the technological process in organizations and the factors, both internal and external, which influence the rate, timing and success of industrial innovations. The interrelationship between science and technology and the importance of these two disciplines to the process of technological innovation is examined. Also discussed is the process of R&D management, the strategic management of technology, the dynamics of technology life cycles and organizational influences on engineering and manufacturing processes. Lecture, Credits 3 (Fall, Spring)

MGMT-743 Advanced Topics in Technology Management
This course is the advanced treatment of topics introduced in the core course offering. MGMT 735. It reviews topics introduced in the core such as disruptive technology and adds significant new content on such topics as user innovation and organizational ambidexterity. Successful completion will prepare students for leadership and significant contributions as group members for any new technology development project. (Prerequisites: MGMT-735 or equivalent course.) Lecture 45, Credits 3 (Spring)

MGMT-745 Social and Political Environment of Business
This class focuses on the interactions among business, government and society. The course illuminates the role of ethics, social ideology and government policy in guiding business decisions and in providing the conditions for successful competitive activity. Attention is given to understanding the reason for government regulation, the pros and cons of various regulatory approaches, and the role of the firm in the policy making process. The class also looks at current debates on corporate social responsibility with regard to stakeholders, including government, consumers, employees, communities and the environment. Lecture, Credits 3 (Fall)

MGMT-750 Human Resource Management
This course focuses on the importance of managing human resources with an awareness of the legal and regulatory environment. Attention is given to the increasing importance of cooperation among top management, human resource managers, line managers and employees. Students will become familiar with workplace planning and employment, human resource development, compensation and benefits, employment and labor relations, occupational health and safety, and managing diversity. (Prerequisites: MGMT-740 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

MGMT-753 Field Experiences in Business Consulting
Students work in consulting teams to assist startup ventures and/or small businesses. Students focus on multiple aspects of consulting including client engagement, negotiating statements of work, project management, and final briefings and reports. From problem identification through the application of relevant analytical models, course projects may focus on a number of areas. For example, they may seek to develop commercialization plans for specific technologies, products, or services; craft marketing plans; focus on unique problems associated with small businesses; and develop growth strategies. Recommended for students nearing the completion of their program. (Prerequisites: ACCT-603 and FINC-721 and MKTG-761 or equivalent courses.) Lecture, Credits 3 (Spring)

MGMT-758 Seminar in Management
Special topics seminars offer an in-depth examination of current events, issues and problems unique to management. Specific topics will vary depending upon student and faculty interest and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. These seminars may be repeated for credit since topics normally vary from semester to semester. (Depends on topic) Lecture, Credits 3

MGMT-759 Competitive Strategy
This course reviews the techniques and tools firms use to create a sustainable competitive advantage in the global economy. Cross-functional analysis is a core element in the course. Topics covered include the mission and vision of the firm, analysis of the external environment, analysis of internal resources and capabilities, the role of innovation in strategy development, analysis of global business strategies, developing and implementing business-level and corporate-level strategies, and managing strategy in the multi-business corporation. *Note: All MBA core courses. (Enrollment in this course requires permission from the department offering the course.) Lecture, Credits 3 (Fall, Spring, Summer)

MGMT-761 Managing Research and Innovation
This course deals with the responsibilities and operating problems of managers responsible for research and innovation within firms. Topics will include: internal technology assessments, the acquisition of technology, domestic and international technology transfer, and the selection and management of research and development projects. Managerial techniques for stimulating and managing innovation are discussed, based on descriptive and prescriptive readings and cases. Particular attention will be given to managing creative individuals, the nature of disruptive technical innovations, and techniques for overcoming barriers to innovation. (Prerequisites: MGMT-742 or MGMT-735 or equivalent courses.) Lecture, Credits 3 (Spring)

MGMT-762 Managing New Product and Product Development
The course deals with the internal organizational challenges faced by managers of innovative and technology-intensive companies. Particular attention is given to management techniques for successfully developing and introducing into the marketplace new products and services. Also discussed are the management of technical groups and project teams, cross-functional integration, and organizational processes and procedures that support innovation and creativity. (Prerequisites: MGMT-742 or MGMT-735 or equivalent courses.) Lecture, Credits 3 (Spring)

MGMT-765 Applied Venture Creation
This project-oriented course enables students to gain multi-disciplinary experience in entrepreneurship, venture creation, or product/service commercialization through a number of alternative venues. Student teams gain applied and practical knowledge by participating in an actual entrepreneurial or commercialization project. These projects include: advancing/maturing a student-originated business concept, developing commercialization plans in partnership with various RIT college product/service development projects, or creating commercial business plans for RIT-generated intellectual property. Students meet with supervising faculty on a weekly basis. *Note: Instructor permission required. Contingent on project and team mix. See a Saunders College graduate adviser for details Lecture, Credits 3 (Fall, Spring, Summer)

MGMT-770 Business Research Methods
This course concerns the development, presentation and use of research in managerial decision making. Included are the processes by which meaningful research problems are generated, identification of the relevant literature, rationalization of the research design and interpretation of findings. Students typically work in small groups to execute a research project in one of the functional areas of business. (Prerequisites: DECS-782 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

MGMT-790 Field Exam Prep
All MS-Management students who do not complete a capstone project will take a field exam at the end of their program. This course provides basic help to students taking this exam. *Note: All required courses in the MS-Management program. CMP 45, Credits 0 (Fall, Spring, Summer)

MGMT-791 Graduate Project
This course is used to fulfill the graduate project requirement for the MS degree in management. The candidate must obtain approval from an appropriate faculty member to supervise the paper before registering for this course. A corporate-oriented research project designed by the candidate and his or her advisor to explore a salient management-related issue. Project, Credits 3 - 6 (Spring, Summer)

MGMT-794 Innovation Project
This course is limited to students in the Master of Science in Innovation Management Program. It is the first of two courses (Innovation Project and Innovation Capstone) that complete the degree program. Students will analyze an innovation issue and develop a plan to put the innovation into practice. Circumstances permitting, they may test the plan. Students will further define the innovation and the project, collect and analyze relevant data and information, develop alternative solutions, and make recommendations to the professor and outside experts as appropriate. Students will integrate knowledge of innovation, creativity, and business practice while developing and applying innovation skills. Students will receive a grade of Incomplete for this course. A final grade for both the Innovation Project and Innovation Capstone courses will be assigned upon completion of the Capstone course. Students will be required to write and have approved by the Program Director a one-page description of their proposed innovation before they register for the class. *Note: Permission of the Program Director. Lecture, Credits 3 (Fall, Spring)
MGMT-799 Independent Study Management
Students work independently under the supervision of a faculty advisor. *Note: Instructor approval Independent Study, Credits 3 (Fall, Spring, Summer)

MGMT-800 Leadership Development I
This course builds on the assessment activities that are part of course MGMT-806. Each student participates in a 360-degree leadership assessment process. Based on this formal review, personal development plans are created and serve as dynamic documentation of individual professional progress. Students attend individual counseling sessions with a leadership coach. Students then take action on the feedback received in order to develop self-awareness. (Corequisite: MGMT-806 or equivalent course) Lecture, Credits 1 (Summer)

MGMT-801 Leadership Development II
This course is a continuation of MGMT-800. Leadership Development II requires student to explore and expand their potential as leaders. Through self and peer assessment, one-on-one coaching, career counseling, and written assignments, students develop leadership goals and create a plan to realize those goals. Students attend individual counseling sessions with a leadership coach. (Prerequisites: MGMT-800 or equivalent course.) Lecture, Credits 1 (Fall)

MGMT-804 Critical Thinking for Decision Making
An introduction to the issues related to managerial problem solving, planning, decision making and implementation in complex organizations. The goal of the course is to help students think systematically about the practice of general management and how managers translate ideas into action. The types of decisions faced by executives and the various approaches available to managers for solving cross-functional, organizational-wide problems are examined. Students learn and practice essential skills required of general managers including critical thinking, problem solving, and oral and written communication. Lecture, Credits 2 (Fall)

MGMT-805 Current Topics Seminar
Current topics seminars offer an in-depth examination of current events, issues and problems. Specific topics will vary depending upon student and faculty interest and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. (Topic-dependent) Lecture, Credits 2 (Fall)

MGMT-806 Team Building and Ethics
During this one-week course, students will understand how to motivate and lead teams as well as how to support the leadership of others. Students will undertake a critical evaluation of the ethical responsibilities of managers and corporations. Each incoming student joins a study group of around four or five students selected for diversity of skills and experience. This course also serves as a general orientation for incoming EMBA students. Lecture, Credits 1 (Summer)

MGMT-810 Leadership
This course focuses on the role of the general manager as a leader in an organization. The course addresses analytical and behavioral strategies and techniques for leadership by examining problem-solving models, personal values, and communications. The emphasis is on the interpersonal skills needed to express different leadership styles and behaviors. Cases, exercises, and class discussions will be used to examine and explore opportunities for managers to become more effective as leaders in modern organizations. (Prerequisites: MGMT-806 or equivalent course.) Lecture, Credits 2 (Fall)

MGMT-860 Executive Leadership Series
The course explores leadership topics in depth with an emphasis on current management and leadership issues. During each class a community leader guest lectures on topics of leadership. Past speakers have included senior-level executives from local industry, government, and not-for-profit organizations. (Prerequisites: MGMT-810 or equivalent course.) Lecture, Credits 2 (Fall)

MGMT-861 Managing Technology, Innovation and Research
This course deals with the responsibilities and challenges faced by managers responsible for research and innovation within high-technology firms. Topics will include: the critical role of innovation, internal technology assessments, technology transfer, the selection and management of R&D projects, and the identification of and management of disruptive technologies and business models. Particular attention will be given to overcoming systemic barriers to innovation. (Prerequisites: MGMT-818 or equivalent course.) Lecture, Credits 2 (Summer)

MGMT-877 Graduate Part-Time Co-op
Half semester of paid MBA related work experience. *Note: Departmental approval required. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Co-op, Credits 0 (Fall, Spring)

MGMT-888 Graduate Co-op Summer
One semester of paid MBA related work experience. *Note: Departmental approval required. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Co-op, Credits 0 (Summer)

MGMT-889 Capstone Consulting Project I
Teams of students analyze specific operational problems or improvement opportunities in client organizations. Under the guidance of a faculty supervisor, teams identify relevant issues, collect data, develop alternatives and make recommendations to the client. The project, a two-course equivalent, is the capstone experience of the Executive MBA program. (Prerequisites: MGMT-818 and FINC-846 and MKTG-851 or equivalent courses.) Lecture, Credits 3 (Summer)

MGMT-890 Capstone Consulting Project II
This course is a continuation of MGMT-889. Teams of students analyze specific operational problems or improvement opportunities in client organizations. Under the guidance of a faculty supervisor, teams identify relevant issues, collect data, develop alternatives and make recommendations to the client. The project, a two-course equivalent, is the capstone experience of the Executive MBA program. (Prerequisites: MGMT-889 or equivalent course.) Lecture, Credits 3 (Fall)

MGMT-899 Graduate Co-op
One semester of paid MBA related work experience. *Note: Departmental approval required. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Co-op, Credits 0 (Fall, Spring, Summer)

Management Information Systems

MGIS-650 Introduction to Data Analytics and Business Intelligence
This course serves as an introduction to data analytics including both descriptive and inferential statistical techniques. Contemporary data analytics and business intelligence tools will be explored through realistic problem assignments. Lecture 45, Credits 3 (Fall)

MGIS-710 Information Systems Concepts
This course is an introduction to the conceptual and theoretical foundations of management information systems and their role in modern organizations. The course will provide students with the concepts, tools and techniques needed to understand and to interpret information management issues, such as how to best incorporate information technology into an organization, from a managerial perspective. Lecture, Credits 3 (Fall, Spring)

MGIS-711 Managing Service Systems
Service science is a new, interdisciplinary field that addresses the shift to the service and information-based economy. Students in this course investigate the nature of services and the need for interdisciplinary approaches to services innovation. Students will explore the role of information technology in the design, management, delivery and evaluation of services and apply these concepts to a specific industry, such as health care, IT services or financial services. Lecture, Credits 3 (Fall)

MGIS-712 Service-Oriented Information Systems
Recent advances in service-oriented IT, such as web services, are playing an increasing role in implementation and innovation with service systems. This course provides an overview of these technologies and their role in service systems. Students will explore web services and service-oriented architectures and examine their usage in service systems to implement business processes and to develop, deliver, manage and innovate in services. Lecture, Credits 3 (Fall, Spring)

MGIS-720 Information Systems Design
This course provides students with fundamental knowledge and skills required for successful analysis of problems and opportunities related to the flow of information within organizations and the design and implementation of information systems to address identified factors. Students are provided with knowledge and experience that will be useful in determining systems requirements and developing a logical design. Lecture, Credits 3 (Fall)
MGIS-725 Data Management and Analytics
This course discusses issues associated with data capture, organization, storage, extraction, and modeling for planned and ad hoc reporting. Enables student to model data by developing conceptual and semantic data models. Techniques taught for managing the design and development of large database systems including logical data models, concurrent processing, data distributions, database administration, data warehousing, data cleansing, and data mining. Lecture, Credits 3 (Spring)

MGIS-730 Information Systems Project Management
This course provides students with fundamental knowledge and skills required for information systems consulting. Topics covered include client relationship management, information systems requirements analysis, proposal development, scope negotiation, costing, knowledge acquisition and management, system design, solutions deployment and systems integration, outsourcing and change management. (Prerequisites: MGIS-720 or equivalent course.) Lecture, Credits 3 (Spring)

MGIS-735 Design and Information Systems
Students who complete this course will understand the principles and practices employed to analyze information needs and design appropriate IT-based solutions to address business challenges and opportunities. They will learn how to conduct requirements analysis, approach the design or redesign of business processes, communicate design decisions to various levels of management, and work in a project-based environment. Lecture 45, Credits 3 (Spring)

MGIS-745 Information Systems Development
Systems Development provides MBA students with the fundamental techniques and concepts necessary for programming in a modern programming language. Emphasis will be placed on object-oriented programming concepts. By the end of the course, students will demonstrate core programming concepts, and be able to write simple business applications. Lecture, Credits 3 (Fall, Spring)

MGIS-758 Seminar in Management Information Systems
Special topics seminars offer an in-depth examination of current events, issues and problems unique to MIS. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from semester to semester. (Instructor determined) Lecture, Credits 3 (Fall, Spring)

MGIS-760 Integrated Business Systems
This course focuses on the concepts and technologies associated with Integrated Business Information Systems and the managerial decisions related to the implementation and ongoing application of these systems. Topics include business integration and common patterns of systems integration technology including enterprise resource planning (ERP), enterprise application integration (EAI) and data integration. The key managerial and organizational issues in selecting the appropriate technology and successful implementation are discussed. Hands-on experience with the SAP R/3 system is utilized to enable students to demonstrate concepts related to integrated business systems. (familiarity with MS Office suite and Internet browsers) Lecture, Credits 3 (Spring)

MGIS-799 Independent Study Management Information Systems
The student will work independently under the supervision of a faculty advisor. (Instructor approval) Independent Study, Credits 3 (Fall, Spring, Summer)

Marketing

MKTG-758 Seminar in Marketing
Special topics seminars offer an in-depth examination of current events, issues and problems unique to marketing. Specific topics will vary depending upon student and faculty interest and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. These seminars may be repeated for credit since topics normally vary from semester to semester. (varies according to topic) Lecture, Credits 3

MKTG-761 Marketing Concepts and Commercialization
An introduction to contemporary principles and practices of marketing. The course is structured around the process of marketing planning leading to the development of successful marketing strategies, including the commercialization of products and services in domestic and international environments. Focus is on environmental scanning techniques, setting and evaluating measurable objectives, innovating and controlling the interrelated components of product/service offering, planning and executing the marketing mix (channels of distribution, price, and promotion), and enhancing customer relationships through the delivery of customer value. Lecture, Credits 3 (Fall, Spring, Summer)

MKTG-762 Advanced Marketing Management
This course is an advanced study of the strategic and operational decisions facing a marketing executive today. Topics covered include marketing management problems, branding and positioning, digital marketing, marketing analytics, marketing research and marketing in the new economy. The course will present various concepts and tools for evaluating the marketplace (external environment, competitors, marketing opportunities and threats), and for analyzing marketing strategies. (Prerequisites: MKTG-761 or equivalent course.) Lecture, Credits 3 (Spring)

MKTG-763 Buyer Behavior
The course reviews the major theories that frame the understanding of both consumer (end-user) and business buying behavior. Topics include the buying decision process, the impact of emotion, product knowledge, and product involvement on purchasing decisions. In addition, behavioral, social and psychological perspectives will be discussed. All perspectives will be applied to designing marketing strategy. (Prerequisites: MKTG-761 or equivalent course.) Lecture, Credits 3 (Fall)

MKTG-764 Channel Management
This course involves a study of the elements and management of marketing channels. A marketing channel is viewed as an inter-organizational system involved with the task of making goods, services and concepts available for consumption by enhancing their time, place and possession utilities. The course focuses on ways channels can be developed and managed to improve efficiency and effectiveness increasing firm profitability. (Prerequisites: MKTG-761 or equivalent course.) Lecture, Credits 3 (Spring)

MKTG-767 Advertising and Integrated Marketing Communications
An in-depth view of tools of advertising, sales promotion, public relations, personal selling, direct marketing and Internet Marketing. Basic concepts of advertising using print, broadcast, Internet and outdoor media are studied. Planning, budgeting and the roles of advertising agencies are also covered. Students develop a comprehensive promotion plan beginning with the marketing strategy and ending with implementation and evaluation. The project, in which the student plans and prepares a promotion/advertising campaign for a product or service in consultation with the instructor is an integral part of the course. (Prerequisites: MKTG-761 or equivalent course.) Lecture, Credits 3 (Spring)

MKTG-768 Marketing Analytics
Marketing analytics is the practice of measuring, managing and analyzing marketing performance to maximize its effectiveness and optimize return on investment (ROI). Understanding marketing analytics allows marketers to be more efficient at their jobs and minimize wasted online and offline marketing dollars. It also provides marketers with the information necessary to help support company investment in marketing strategy and tactics. This course provides the participant with the necessary knowledge and practical insights that will help a marketing manager get more out of available data and take strategic advantage of the analysis. This interactive, participatory training is designed to answer key questions: “What are marketing analytics, how can marketing analytics improve my marketing efforts and how can I integrate marketing analytics into my business?” (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall)

MKTG-771 Marketing Research Methods
This course provides an overview of marketing research and practice, especially the methods of measuring, examining, and predicting factors that affect the marketing process. Students will learn about the process of conducting surveys and experiments that includes the following: determining customer requirements, questionnaire design, telephone, mail and electronic surveys, sampling plan design and data analysis. (Prerequisites: MKTG-761 and DECS-782 or equivalent courses.) Lecture, Credits 3 (Fall, Spring)

MKTG-773 Database Marketing
This course provides the student with the application of database management to the challenges of relationship marketing. The students will be taught data mining tools which they will use to conduct an analysis of a database and apply it to the design of a relationship marketing plan. (Prerequisites: MKTG-761 and DECS-782 or equivalent courses.) Lecture, Credits 3 (Fall, Spring)

MKTG-775 Business-to-Business E-Marketing
The focus of this course is on the effective integration and coordination of various business-to-business marketing operations within the realm of e-commerce. The course explores from a marketing perspective factors critical to the success of e-business operations and examines the strategies and tactics that organizations can use to build and/or enhance their business to business relationships using electronic tools. (Prerequisites: MKTG-761 or equivalent course.) Lecture, Credits 3
Pay-Per-Click Advertising
Pay-Per-Click advertising empowers digital marketers to precisely target consumers who show specific interest in their products and services. Also referred to as the cost-per-click advertising it allows the marketer to display relevant advertisements both on search engines as well as third party websites that maximize click through rates without wasting impressions. The course includes topics that cover an overview of direct response advertising principles, campaign setup, targeting, landing page testing, developing and deploying search marketing campaigns for the search and display networks on major search engines such as Google. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 45, Credits 3 (Fall)

Independent Study, Credits 3 (Fall, Spring, Summer)

Marketing Strategy
A general management perspective on the critical impact of marketing in organizations. Topics include an overview of the marketing process, market research, segmentation, and target markets. The focus is on the process of creating, communicating, and delivering customer value through the marketing mix. The course is structured around the managerially controllable elements of product, price, promotion and distribution, plus the interrelationships of these elements. (Pre or Corequisites: MGMT-818 or equivalent course.) Lecture, Credits 2 (Spring)
Course numbering: RIT courses are generally referred to by their alphanumeric registration label. The Four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100-299), upper division (300-599), or graduate level (600 and above).

Unless otherwise noted, the following courses are offered annually. Specific times and dates can be found in each semester’s schedule of courses. Prerequisites/corequisites are noted in parentheses near the end of the course description.

**Computer Science**

**CSCI-602**  
**Intersession Adv C++ Program**  
The goal of the course is to fill the student gaps of knowledge in CSCI-603 Advanced C++ and Program Design. Topics include but are not limited to: UML, Inheritance, Memory Management, Templates, Function Pointers, and Operator Overloading. There will be several programming homework assignments. The course will meet 8 hours per week, in two-hour sessions, four days a week. (Enrollment in this course requires permission from the department offering the course.) **Lecture 8, Credits 0 (Int)**

**CSCI-603**  
**Computational Problem Solving**  
This course focuses on the application of computational thinking using a problem-centered approach. Specific topics include: expression of algorithms in pseudo-code and a programming language; elementary data structures such as lists, trees and graphs; problem solving using recursion; and debugging and testing. Assignments (both in class and homework) requiring a pseudo-code solution and implementation in a programming language are an integral part of the course. Note: This course serves as a bridge course for graduate students and cannot be taken by undergraduate students without permission from the CS Undergraduate Program Coordinator. **Lecture 3, Credits 3 (Fall, Spring)**

**CSCI-604**  
**Intersession Advanced Java Programming**  
The goal of the course is to fill the student gaps of knowledge in CSCI-605 Advanced Java Programming. Topics include but are not limited to: Collection Framework, Threads, Synchronization, Network Programming, and Remote Method Invocation. There will be several programming homework assignments. The course will meet 8 hours per week, in two-hour sessions, four days a week. (Enrollment in this course requires permission from the department offering the course.) **Lecture 8, Credits 0 (Int)**

**CSCI-605**  
**Advanced Object-Oriented Programming Concepts**  
This course focuses on identifying advanced object-oriented programming concepts and implementing them in the context of specific problems. This course covers advanced concepts such as event-driven programming, design patterns, distributed and concurrent programming, and the use, design and implementation of applications. Assignments (both in class and homework) requiring a solution to a problem and an implementation in code are an integral part of the course. Note: This course serves as a bridge course for graduate students and cannot be taken by undergraduate students without permission from the CS Undergraduate Program Coordinator. **Lecture 3, Credits 3 (Fall, Spring)**

**CSCI-610**  
**Foundations of Computer Graphics**  
Foundations of Computer Graphics is a study of the hardware and software principles of interactive raster graphics. Topics include an introduction to the basic concepts, 2-D and 3-D modeling and transformations, viewing transformations, projections, rendering techniques, graphical systems and applications. This course will focus on rasterization techniques and emphasize the hardware rasterization pipeline including the use of hardware shaders. Students will use a standard computer graphics API to reinforce concepts and study fundamental computer graphics algorithms. Programming projects and a survey of the current graphics literature will be required. Note: students who complete CSCI-510 may not take CSCI-610 for credit. (Prerequisites: (CSCI-603 or CSCI-602) and (CSCI-605 or CSCI-604) or equivalent courses with grades of B or better or successful completion of CSCI-243 or 4003-334.) **Lecture 3, Credits 3 (Fall, Spring)**

**CSCI-620**  
**Introduction to Big Data**  
This course provides a broad introduction to the exploration and management of large datasets being generated and used in the modern world. First, practical techniques used in exploratory data analysis and mining are introduced; topics include data preparation, visualization, statistics for understanding data, and grouping and prediction techniques. Second, approaches used to store, retrieve, and manage data in the real world are presented; topics include traditional database systems, query languages, and data integrity and quality. Case studies will examine issues in data capture, organization, storage, retrieval, visualization, and analysis in diverse settings such as urban crime, drug research, census data, social networking, and space exploration. Big data exploration and management projects, a term paper and a presentation are required. (Prerequisites: CSCI-603 or CSCI-602 or CSCI-605 or CSCI-604 or CSCI-243 or 4003-334 or equivalent course and sufficient background in statistics.) **Lecture 3, Credits 3 (Fall, Spring)**

**CSCI-621**  
**Database System Implementation**  
This course provides a broad introduction to database management systems including data modeling, the relational model, and SQL. Database system implementation issues are covered next, where the focus is on data structures and algorithms used to implement database management systems. Topics include physical database organizations, indexing and hashing, query processing and optimization, database recovery techniques, transaction management, currency control, and database performance evaluation. Current research topics in database system implementation are also explored. Programming projects, a term paper, and presentation will be required. (Prerequisites: CSCI-620 or CSCI-420 or CSCI-320 or (4003-485 and 4003-487) or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

**CSCI-622**  
**Data Security and Privacy**  
This course examines policies, methods and mechanisms for securing enterprise and personal data and ensuring data privacy. Topics include data integrity and confidentiality; access control models; secure database architectures; secure transaction processing; information flow, aggregation, and inference controls; auditing; securing data in contemporary (relational, XML and other NO SQL) database systems; data privacy; and legal and ethical issues in data protection. Programming projects are required. (Prerequisites: CSCI-620 or CSCI-420 or CSCI-320 or (4003-485 and 4003-487) or equivalent course.) **Lecture 3, Credits 3 (Spring)**

**CSCI-630**  
**Foundations of Intelligent Systems**  
An introduction to the theories and algorithms used to create intelligent systems. Topics include search algorithms (e.g. A*, iterative deepening), logic, planning, knowledge representation, machine learning, and applications from areas such as computer vision, robotics, natural language processing, and expert systems. Programming assignments and oral/written summaries of research papers are required. Note: students who complete CSCI-331 may not take CSCI-630 for credit. (Prerequisites: Completion of (CSCI-603 or CSCI-602) and (CSCI-605 or CSCI-604) and (CSCI-661 or CSCI-660) with grades of B or better. Prerequisite may also be satisfied by successful completion of (CSCI-243 or 4003-334) and (CSCI-262 or CSCI-263).) **Lecture 3, Credits 3 (Fall, Spring)**

**CSCI-631**  
**Foundations of Computer Vision**  
An introduction to the underlying concepts of computer vision and image understanding. The course will consider fundamental topics, including image formation, edge detection, texture analysis, color, segmentation, shape analysis, detection of objects in images and high level image representation. Depending on the interest of the class, more advanced topics will be covered, such as image database retrieval or robotic vision. Programming assignments are an integral part of the course. Note: students who complete CSCI-431 may not take CSCI-631 for credit. (Prerequisites: Completion of (CSCI-603 or CSCI-602) and (CSCI-605 or CSCI-604) and (CSCI-661 or CSCI-660) with grades of B or better. Prerequisite may also be satisfied by successful completion of (CSCI-243 or 4003-334) and (CSCI-262 or CSCI-263).) **Lecture 3, Credits 3 (Fall, Spring)**
CSCI-632 Mobile Robot Programming
This course covers standard and novel techniques for mobile robot programming, including software architectures, reactive motion control, map building, localization and path planning. Other topics may include multiple robot systems, robot vision and non-traditional and dynamic robots. Students will implement various algorithms in simulation as well as on a real robot, and investigate and report on current research in the area. Course offered every other year. (Prerequisites: CSCI-630 or CSCI-331 or equivalent course.) Lecture 3, Credits 3 (Spring)

CSCI-633 Biologically Inspired Intelligent Systems
There have been significant advances in recent years in the areas of neuroscience, cognitive science and physiology related to how humans process information. In this course students will focus on developing computational models that are biologically inspired to solve complex problems. A research paper and programming project on a relevant topic will be required. A background in biology is not required. (Prerequisites: Completion of (CSCI-603 or CSCI-602) and (CSCI-605 or CSCI-604) and (CSCI-661 or CSCI-660) with grades of B or better. Prerequisite may also be satisfied by successful completion of (CSCI-243 or 4003-334) and (CSCI-262 or CSCI-263).) Lecture 3, Credits 3 (Fall)

CSCI-641 Advanced Programming Skills
The goal of this course is to introduce the students to a programming paradigm and an appropriate programming language chosen from those that are currently important or that show high promise of becoming important. A significant portion of the learning curve occurs through programming assignments with exemplary solutions discussed later in class. The instructor will post specifics prior to registration. With the approval of the program coordinator, the course can be taken for credit more than once, provided each instance deals with a different paradigm and language. A term project involving independent investigation is also required. Note: students who complete CSCI-541 may not take CSCI-641 for credit. (Prerequisites: (CSCI-603 or CSCI-602) and (CSCI-605 or CSCI-604) or equivalent courses with grades of B or better or successful completion of CSCI-243 or 4003-334.) Lecture 3, Credits 3 (Fall, Spring)

CSCI-642 Secure Coding
This course provides an introduction to secure coding including topics such as principles of secure coding, security architectures and design, operational practices and testing, programmatic use of cryptography, and defenses against software exploitation. Other topics include software based fault isolation, type-safe languages, certifying compilers; proof-carrying code, and automated program analysis and program rewriting. Programming projects, presentations, and a term paper will be required. (Prerequisites: (CSCI-663 or CSCI-602) and (CSCI-605 or CSCI-604) or equivalent courses with grades of B or better or successful completion of CSCI-243 or 4003-334.) Lecture 3, Credits 3 (Fall)

CSCI-651 Foundations of Computer Networks
This course is an introduction to the concepts and principles of computer networking. Students will design and implement projects using application protocols, and will study transport, network, and data link protocols and algorithms. The course also includes an introduction to local area networks, data transmission fundamentals, and network security. Programming projects and reading research papers will be required. (Prerequisites: CSCI-605 or CSCI-604 or CSCI-243 or 4003-334 or equivalent course and sufficient background in statistics.) Lecture 3, Credits 3 (Fall)

CSCI-652 Distributed Systems
An introduction to the study of distributed systems. The course covers distributed system architectures such as client-server and peer-to-peer, distributed system design issues such as communication, fault tolerance, coordination, and deadlock, distributed system middleware such as remote method invocation (RMI) and tuple space, and the theory of distributed algorithms such as logical clocks and leader election. Programming projects are required. (Prerequisites: CSCI-603 or CSCI-602 or CSCI-243 and sufficient background in Operating Systems or (4003-334 and 4003-345) or equivalent courses.) Lecture 3, Credits 3 (Fall, Spring)

CSCI-654 Foundations of Parallel Computing
This course is a study of the hardware and software issues in parallel computing. Topics include an introduction to the basic concepts, parallel architectures and network topologies, parallel algorithms, parallel metrics, parallel languages, granularity, applications, parallel programming design and debugging. Students will become familiar with various types of parallel architectures and programming environments. (Prerequisites: Completion of (CSCI-603 or CSCI-602) and (CSCI-605 or CSCI-604) and (CSCI-661 or CSCI-660) with grades of B or better. Prerequisite may also be satisfied by successful completion of (CSCI-243 or 4003-334) and (CSCI-262 or CSCI-263).) Lecture 3, Credits 3 (Fall)

CSCI-660 Intersections Found CS Theory
The goal of the course is to fill the student gaps of knowledge in CSCI-661Foundations of Computer Science Theory. Topics include but are not limited to: DFAs and NFAs, Regular Expressions and Kleene’s Theorem, Myhill-Nerode and Minimization, Pumping Lemma for Regular Languages, CFLs and PDAs, Pumping Lemma for Context-Free Languages, Turing Machines, Complexity. The course will meet 8 hours per week, in two-hour sessions, four days a week. (Enrollment in this course requires permission from the department offering the course.) Lecture 8, Credits 0 (Int)

CSCI-661 Foundations of Computer Science Theory
This course provides an introduction to the theory of computation, including formal languages, grammars, automata theory, computability, and complexity. This course serves as a bridge course for graduate students and cannot be taken by undergraduate students without permission from the CS Undergraduate Program Coordinator. Note: Students who complete CSCI 262 or CSCI 263 may not take CSCI 661 for credit. (Sufficient background in discrete mathematics and programming is required. Student standing in COMPSCI-MS, any Computer Science BS/MS program or COMPIS-PHD is also required.) Lecture 3, Credits 3 (Fall, Spring)

CSCI-662 Foundations of Cryptography
This course provides an introduction to cryptography, its mathematical foundations, and its relation to security. It covers classical cryptosystems, private-key cryptosystems (including DES and AES), hashing and public-key cryptosystems (including RSA). The course also provides an introduction to data integrity and authentication. Note: students who complete CSCI-662 may not take CSCI-662 for credit. (Prerequisites: Completion of (CSCI-603 or CSCI-602) and (CSCI-605 or CSCI-604) and (CSCI-661 or CSCI-660) with grades of B or better. Prerequisite may also be satisfied by successful completion of (CSCI-243 or 4003-334) and (CSCI-262 or CSCI-263).) Lecture 3, Credits 3 (Fall)

CSCI-664 Computational Complexity
This course provides an introduction to computational complexity theory. It covers the P=NP problem, time and space complexity, randomization, approximability, and relativization. Course offered every other year. (Prerequisites: (CSCI-661 or CSCI-660 or CSCI-262 or CSCI-263) and (CSCI-665 or CSCI-261 or CSCI-264) or equivalent courses.) Lecture 3, Credits 3 (Spring)

CSCI-665 Foundations of Algorithms
This course provides an introduction to the design and analysis of algorithms. It covers a variety of classical algorithms and their complexity and will equip students with the intellectual tools to design, analyze, implement, and evaluate their own algorithms. Note: students who take CSCI-261 or CSCI-264 may not take CSCI-665 for credit. (Prerequisites: Completion of (CSCI-603 or CSCI-602) and (CSCI-605 or CSCI-604) and (CSCI-661 or CSCI-660) with grades of B or better. Prerequisite may also be satisfied by successful completion of (CSCI-243 or 4003-334) and (CSCI-262 or CSCI-263).) Lecture/Lab 3, Credits 3 (Fall, Spring)

CSCI-686 Graduate Professional Seminar
This course provides students with skills required to succeed as Computer Science professionals, balancing the divergent needs of computing technology, employee, employer, and societal needs. Topics covered include skills in professional communication; skills to determine and effectively address needs of diverse audiences; research skills such as the ability to perform a literature review, design and conduct studies; team participation and management skills; conflict management; and skills to handle legal, ethical and societal challenges faced by CS professionals. Lecture 3, Credits 3 (Fall, Spring, Summer)

CSCI-687 Graduate Research Seminar
This course provides students with the theoretical background and practical application of various research methods that can be used in computing and information sciences. The course provides an overview of the research process and literature review, and provides initial study in correlation and experimental research methods and design. Students will analyze several existing research studies and design and conduct studies. Lecture 3, Credits 3 (Fall, Spring, Summer)

CSCI-709 Topics in Computer Science
This course examines current topics in Computer Science. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific seminar course in this area. Specific course instances will be identified as belonging to no cluster; hence, such courses will count only as general Computer Science electives. Lecture/Lab 3, Credits 3
CSCI-711 Global Illumination
This course will investigate the theory of global illumination (GI) in computer image synthesis. Seminal computer graphics papers will be used to explore the various components of the GI pipeline and explain how the path of light in a virtual scene can be simulated and used to create photorealistic imagery. The course will emphasize the theory behind various GI rendering tools and libraries available for image synthesis. The student will put theory into practice via a set of programming assignments and a capstone project. Topics will include light and color, three-dimensional scene specification, camera models, surface materials and textures, GI rendering methods, procedural shading, tone reproduction, and advanced rendering techniques. Readings and summaries of Computer Graphics literature will be required. (Prerequisites: CSCI-610 or CSCI-510 or 4003-570 or equivalent course.) Lecture 3, Credits 3 (Fall, Spring)

CSCI-713 Applied Perception in Graphics and Visualization
The goal of this course is to introduce students to the field of applied perception in graphics and visualization and demonstrate how it has contributed to the development of better display systems and computer graphics rendering techniques. The delivery of the course material will be done primarily through lectures with biweekly programming assignments based upon the techniques presented in class. Students will also be exposed to a wide range of technical papers and be expected to make classroom presentations on selected topics in the field of applied perception in graphics and visualization. (Prerequisites: CSCI-610 or CSCI-510 or 4005-762 or 4003-571 or equivalent course.) Lecture 3, Credits 3 (Spring)

CSCI-714 Scientific Visualization
Visualizations of scientific data are helpful in order to understand complex, n-dimensional behavior of simulations. This course covers techniques that are needed to visualize n-dimensional data sets produced by real scientific simulations. Topics include: Visualization design, discrete visualization techniques, scalar and volume visualization techniques and perception of visualizations. Additionally topics such as distributed file systems, specialized file systems and distributed computing needed in order to create the visualizations will be covered. A team project and presentations are required. Course offered every other year. (Prerequisites: CSCI-610 or CSCI-510 or 4005-762 or 4003-572 or equivalent course.) Lecture 3, Credits 3 (Spring)

CSCI-715 Applications in Virtual Reality
This course will investigate the application of virtual reality software and technology within a given domain. Working in sets of technical teams, students will collectively investigate and solve a large-scale visualization task within that problem domain. Focus of individual student teams may include (but is not limited to) distributed VR framework, viewing applications, interaction with VR devices / displays, and audio in virtual environments. Students will be required to read and summarize selected articles from VR literature, as well as papers specific to the problem domain being investigated, to assist in making design decisions. A report or survey of one aspect of using a virtual reality system within the given domain is also required. Students should have a strong programming background and a proficiency in a 3D API (OpenGL, DirectX, or Java3D). Students with expertise in distributed systems and an interest in Graphics or virtual reality are also encouraged to register. Offered every other year. (Prerequisites: CSCI-610 or CSCI-510 or 4005-762 or 4003-573 or equivalent course.) Lecture/Lab 3, Credits 3 (Fall)

CSCI-716 Computational Geometry
Computational Geometry is a subfield of algorithm theory that involves the design and analysis of efficient algorithms for problems involving geometric input and output. In this course the focus will be largely on problems in 2-dimensional space (lines, line segments, polygons, planes, polyhedral, curved objects, etc.) with occasional inclusion of higher dimensional problems. There are many fields of computer science that deal with solving problems of a geometric nature. These include computer graphics, computer vision and image processing, robotics, computer-aided design and manufacturing, computational fluid dynamics, and geographic information systems, to name a few. One of the goals of this computational geometry course is to provide the basic geometric tools necessary to solve problems in these fields. Note: Programming projects are required. (Prerequisites: CSCI-261 or CSCI-264 or CSCI-665 or equivalent course.) Lecture 3, Credits 3 (Spring)

CSCI-719 Topics in Computer Graphics
This course examines current topics in Computer Graphics. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. Specific course instances presented will be identified as belonging to the Computer Graphics and Visualization cluster. Lecture 3, Credits 3

CSCI-720 Big Data Analytics
This course provides a graduate-level introduction to the concepts and techniques used in data mining. Topics include the knowledge discovery process, prototype development and building data mining models, current issues and application domains for data mining, and legal and ethical issues involved in collecting and mining data. Both algorithmic and application issues are emphasized to permit students to gain the knowledge needed to conduct research in data mining and apply data mining techniques in practical applications. Data mining projects, a term paper, and presentations are required. (Prerequisites: CSCI-620 or CSCI-420 or CSCI-320 or (4003-485 and 4003-487) or equivalent course.) Lecture 3, Credits 3 (Fall, Spring)

CSCI-721 Data Cleaning and Preparation
This course provides an introduction to the concepts and techniques used in preparing data for subsequent data mining. Topics include the knowledge discovery process, data exploration and its role; data extraction, cleaning, integration and transformation; handling numeric, unstructured, text, web, and other forms of data; and ethical issues underlying data preparation and mining. Data cleaning projects, a term paper, and presentations are required. (Prerequisites: CSCI-620 or CSCI-420 or CSCI-320 or (4003-485 and 4003-487) or equivalent course.) Lecture 3, Credits 3 (Spring)

CSCI-729 Topics in Data Management
This course examines current topics in Data Management. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. Specific course instances will be identified as belonging to the Data Management cluster, the Security cluster, or both clusters. (Prerequisites: CSCI-720 or equivalent course.) Lecture 3, Credits 3 (Fall, Spring)

CSCI-731 Advanced Computer Vision
This course examines advanced topics in computer vision including motion analysis, video processing and model based object recognition. The topics will be studied with reference to specific applications, for example video interpretation, robot control, road traffic monitoring, and industrial inspection. A research paper, an advanced programming project, and a presentation will be required. (Prerequisites: CSCI-631 or 4003-758 or CSCI-431 or equivalent course.) Lecture 3, Credits 3 (Spring)

CSCI-732 Image Understanding
This course explores the theory and methodologies used to interpret images in terms of semantic content. Techniques from image processing and pattern recognition are extended for the purpose of scene understanding using both a bottom-up and a top-down approach. Topics include human visual perception, knowledge representation, object recognition, contextual classification, scene labeling, constraint propagation, interpretation trees, semantic image segmentation, 3D models and matching, active vision, and reasoning about images. Programming projects are required. Offered every other year. (Prerequisites: CSCI-631 or 4003-758 or CSCI-431 or equivalent course.) Lecture 3, Credits 3 (Spring)

CSCI-733 Foundations of Intelligent Security Systems
The course will introduce students to the application of intelligent methodologies applications in computer security and information assurance system design. It will review different application areas such as intrusion detection and monitoring systems, access control and biological authentication, firewall structure and design. The students will be required to implement a course project on design of a particular security tool with an application of an artificial intelligence methodology and to undertake research and analysis of artificial intelligence applications in computer security. (Prerequisites: CSCI-630 or CSCI-651 or CSCI-331 or equivalent course.) Lecture/Lab 3, Credits 3 (Spring)

CSCI-734 Neural Networks and Machine Learning
The course will introduce students into the current state of artificial neural networks. It will review different application areas such as intrusion detection and monitoring systems, pattern recognition, access control and biological authentication, and their design. The students will be required to conduct research and analysis of existing applications and tools as well as to implement a course programming project on design of a specified application based on neural networks and/or fuzzy rules systems. (Prerequisites: CSCI-630 or CSCI-331 or equivalent course.) Lecture/Lab, Credits 3 (Spring)

CSCI-737 Pattern Recognition
An introduction to pattern classification and structural pattern recognition. Topics include Bayesian decision theory, evaluation, clustering, feature selection, classification methods (including linear classifiers, nearest-neighbor rules, support vector machines, and neural networks), classifier combination, and recognizing structures (e.g. using HMMs and SCDGs). Students will present current research papers and complete programming projects such as optical character recognizers. Offered every other year. (Prerequisites: CSCI-630 or CSCI-331 or equivalent course.) Lecture 3, Credits 3 (Fall)
CSCI-739 Topics in Intelligent Systems
This course examines current topics in Intelligent Systems. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. Specific course instances will be identified as belonging to the Intelligent Systems cluster, the Computational Vision and Acoustics cluster, the Security cluster, or some combination of these three clusters. Course offered every other year. Lecture/Lab 3, Credits 3 (Fall)

CSCI-740 Programming Language Theory
This course is an introduction to the formal study of programming languages, demonstrating important intellectual tools for the precise description of programming languages and investigating the essential features of programming languages using these tools. Topics include: dynamic semantics (such as operational semantics); static semantics (such as type systems); proofs by induction on structures and derivations; formal treatment of essential programming-language features (such as assignment, scope, functions, objects, and threads). Both written and programming assignments will be required. (Prerequisites: Completion of (CSCI-603 or CSCI-602) and (CSCI-605 or CSCI-604) and (CSCI-661 or CSCI-660) with grades of B or better. Prerequisite may also be satisfied by successful completion of (CSCI-243 or 4003-334) and (CSCI-262 or CSCI-263).) Lecture/Lab 3, Credits 3 (Fall)

CSCI-742 Compiler Construction
This course discusses design and implementation of language processors and translators. Topics include lexical, syntactic, and semantic descriptions, algorithms for analysis tools, and programming techniques, as well as interpreters and code generation for typical computer architectures. Teams of students will be required to design and implement a programming language with nested block structure and data aggregates. (Prerequisites: Completion of (CSCI-603 or CSCI-602) and (CSCI-605 or CSCI-604) and (CSCI-661 or CSCI-660) with grades of B or better. Prerequisite may also be satisfied by successful completion of (CSCI-243 or 4003-334) and (CSCI-262 or CSCI-263).) Lecture 3, Credits 3 (Spring)

CSCI-746 Software Development Tools
This course investigates and evaluates various software tools used in the development of software. Topics include simple dependency-based tools such as make and ant as well as full-featured integrated development environments. Working with and proposing modeling languages for such tools is an important part of the course. Programming projects will be required. (Prerequisites: Completion of (CSCI-603 or CSCI-602) and (CSCI-605 or CSCI-604) and (CSCI-661 or CSCI-660) with grades of B or better. Prerequisite may also be satisfied by successful completion of (CSCI-243 or 4003-334) and (CSCI-262 or CSCI-263).) Lecture 3, Credits 3 (Spring)

CSCI-749 Topics in Languages and Tools
This course examines current topics in Languages and Tools. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. Specific course instances will be identified as belonging to the Languages and Tools cluster, the Security cluster, or both clusters. Lecture 3, Credits 3

CSCI-759 Topics in Systems
This course examines current topics in Systems. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. Specific course instances will be identified as belonging to the Distributed Systems cluster, the Architecture and Operating Systems cluster, the Security cluster, or some combination of these three clusters. Lecture 3, Credits 3

CSCI-762 Advanced Cryptography
This course investigates advanced topics in cryptography. It begins with an overview of necessary background in algebra and number theory, private- and public-key cryptosystems, and basic signature schemes. The course will cover number theory and basic theory of Galois fields used in cryptography; history of primality algorithms and the polynomial-time test of primality; discrete logarithm based cryptosystems including those based on elliptic curves; interactive protocols including the role of zero-knowledge proofs in authentication; construction of untraceable electronic cash on the net; and quantum cryptography, and one or more of digital watermarking, fingerprinting and stenography. Programming will be required. (Prerequisites: CSCI-662 or CSCI-462 or equivalent course.) Lecture 3, Credits 3 (Spring)

CSCI-769 Topics in Theory
This course examines current topics in Theory. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. Specific course instances will be identified as belonging to the Theory cluster, the Security cluster, or both clusters. Seminar 3, Credits 3

CSCI-789 Computer Science MS Project Colloquium
Students who choose the Computer Science MS project option must complete a faculty- or student-defined capstone project. The descriptions of the faculty-defined project can be found on the Computer Science department web pages. A student-defined project must be defined in collaboration with a faculty adviser before registering for this course. Students will meet with their advisor regularly and submit project deliverables at specified times during the semester. In-class presentations are required and will be critiqued, and a summary project report and public presentation of the project in poster form will occur at the end of the semester. Project 2, Credits 0 (Fall, Spring)

CSCI-888 CS Graduate Summer Co-op
Students perform professional work related to Computer Science for which they are paid. Students must complete a student co-op work report for each term for which they are registered; students are also evaluated each term by their employer. A satisfactory grade is given for co-op when both a completed student co-op work report and a completed, corresponding employer evaluation are received and when both documents are generally consistent. When registered for co-op, students are considered by RIT to have full-time status. In order to register for co-op for summer term, we expect that students will work a minimum of 10 weeks and work a minimum of 35 hours per week. Note: Co-op is an optional part of the M.S. in Computer Science degree. (Enrollment in this course requires permission from the department offering the course.) Co-op, Credits 0 (Summer)

CSCI-909 Proposal Development
MS Students who are preparing for their capstone experience. (Enrollment in this course requires permission from the department offering the course.) Research, Credits 0 (Fall, Spring, Summer)

Computing and Information Sciences

CISC-807 Teaching Skills Workshop
Teaching is a valuable and desirable skill for PhD students. This workshop course provides an introduction to the concepts and skills needed for quality teaching in higher education. Students will be provided with lecture, reading, and class activities centered on building skills in educational analysis, design, and assessment. Prerequisites: Limited to students in the Ph.D. program. Class 2, Credit 2 (F) (This course is restricted to students in the COMPIS-PHD program.) Lecture 2, Credits 2 (Spring)

CISC-810 Research Foundations
This course provides students with the theoretical background and practical experience with a variety of research techniques and methods. The course provides an overview of the research process along with opportunities for hands-on projects. Major topics for the course include: formulating research questions, conducting literature reviews, selecting appropriate methodologies, data sampling, analyzing statistics, qualitative techniques, technical writing research papers, and presentation skills. (Knowledge in probability and statistics, or permission of instructor) (This course is restricted to students in the COMPIS-PHD program.) Lecture 3, Credits 3 (Fall)

CISC-830 Cyberinfrastructure Foundations
Cyberinfrastructure integrates all parts of large-scale computing including a set of software, services, and tools in order to solve large-scale computing problems. This course will give an overview of the problems and solutions of large-scale computing, e.g., Large Hydrox Collider. Students will design and develop new tools for cyberinfrastructure. Presentations and written reports are required. Note: Knowledge in data structure and object-oriented design, or permission of instructor is required. (This course is restricted to students in the COMPIS-PHD program.) Lecture 3, Credits 3 (Spring)

CISC-835 Connectivity
This course studies commonalities underlying a variety of networks including social networks, communication networks, biological networks, the Web, and even an abstract model of networks like graphs. Topics include basic graph theory; graph algorithms, fundamental and emerging concepts in networking, and the analytical and heuristic tools that people use to develop and analyze connectivity in networks. Computing and programming exercises will be required to provide hands-on experience with selected tools and technologies. Note: CSCI-651 or equivalent knowledge in concepts and principles of computer networks, or permission of instructor is required. (Prerequisites: CSCI-651 or equivalent course.) Lecture 3, Credits 3 (Spring)
CISC-849 PhD Seminar
Current advances in computing and information sciences. (This course is restricted to students in the COMPIS-PHD program.) Lecture, Credits 1 - 3 (Fall, Spring)

CISC-860 Optimization Methods
In this course, the basic knowledge and skills of optimization will be introduced. Students will learn how to recognize, formulate, and solve linear and nonlinear optimization problems. The concentration will be focused on the algorithms and applications, with the necessary theories presented in a comprehensive way. The characteristics of linear and nonlinear programming problems will be discussed with the corresponding solutions, such as the simplex method and Karmarkar’s method for linear optimization, and Newton’s method and Powell’s method for nonlinear optimization. Students are required to complete a project on a given problem, or a problem of their own choices but approved by the course instructor, to gain practical experience. Note: Knowledge in linear algebra and calculus, experiences in computer programming/MATLAB, or permission of instructor is required. (This course is restricted to students in the COMPIS-PHD program.) Lecture, Credits 3 (Fall)

CISC-861 Numerical Methods
This course introduces the knowledge and skills of numerical methods. Numerical methods are the bases of computational analysis to approximate complicated formulations whose analytical solutions are unavailable or infeasible. Numerical methods provide computational algorithms to solve mathematical problems, for example, integration, differentiation, and large systems of linear or nonlinear equations. The course is focused on the algorithms and applications, presented with the rationales, benefits, and limitations so that students can choose the appropriate methods with the highest computational efficiency, stability, and accuracy based on the characteristics of the problems. Students are required to complete a project on a given problem, or a problem of their own choice but approved by the course instructor, to gain practical experience. Note: Knowledge in linear algebra and calculus, experiences in computer programming/MATLAB, or permission of instructor is required. (This course is restricted to students in the COMPIS-PHD program.) Lecture, Credits 3 (Spring)

CISC-862 Computational Modeling and Simulation
Everyone uses modeling and simulation even without being aware of it. This course talks about mathematical and computational modeling and simulation as the tools to solve complex problems in the real world. Topics are divided by the category of modeling method: phenomenological models vs. mechanistic models. For mechanistic models, the course will cover differential equations (including variational principle to construct the differential equations, solutions to ordinary differential equations (ODE), and classical ODE systems) and cellular automaton in detail, and mention other mechanistic models. Similarly, for phenomenological models, the course will cover regression and neural networks in detail, and introduce other phenomenological models such as networks and power-law distributions. In parallel, paper review and discussion will serve as case studies of modeling of real-world complex systems, illustrating application domains. Course projects are required. Note: Knowledge in probability and statistics, linear algebra and calculus, experiences in computer programming/MATLAB, or permission of instructor is required. (This course is restricted to students in the COMPIS-PHD program.) Lecture, Credits 3 (Spring)

CISC-863 Statistical Machine Learning
This course will cover supervised learning (linear methods, template methods, neural networks, decision trees, support vector machines), unsupervised learning (clustering, principal and independent components analysis), and related ideas (optimization, learning theory, Bayesian techniques, regularization, cross-validation, and the bias-variance tradeoff). Each student will complete several project sets, including both mathematical and computer implementation problems. (Knowledge in probability and statistics, linear algebra and calculus, experiences in computer programming, or permission of instructor.) Note: Familiarity with a numerical mathematics package (e.g. Matlab, Maple, Mathematica) is helpful but not required. (This course is restricted to students in the COMPIS-PHD program.) Lecture, Credits 3 (Fall)

CISC-864 Medical Imaging and Image Informatics: Principles and Algorithms
Tomographic medical images, along with computer-aided image processing and understanding methods, have been widely utilized in clinical practice for health evaluation and disease detection. This course focuses on the principles of medical imaging technology, i.e. physiological origins, data acquisition and image formation, as well as algorithmic strategies for quantitative understanding of various medical images. It provides students with a general physics-signal-system understanding of the medical imaging modalities. The course also addresses the clinical needs, the technical problems, and the rationales and strategies of quantitative image analysis. Current and potential clinical applications will be used as illustrations throughout the course. The course also strives to demonstrate the general process of conducting applied research, from problem finding through scientific analysis, solution proposal, implementation, experimentation and evaluation. Note: Knowledge in probability and statistics, linear algebra, calculus, and image processing/computer vision, experiences in computer programming or MATLAB, or permission of instructor is required. (This course is restricted to students in the COMPIS-PHD program.) Lecture, Credits 3 (Spring)

CISC-890 Dissertation and Research
Students will perform use-inspired original research in the interaction, informatics, and infrastructure areas of computing and information sciences applied to specific domain(s). Students will receive guidance from their advisor(s) in choosing an appropriate topic and activity. Note: Permission of the Ph.D. Director is required. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 32 (Fall, Spring, Summer)

CISC-897 Research Co-op
This course provides an opportunity for Ph.D. students to complete a formal internship in a business, industry, government, educational, or research setting. The internship provides students with the opportunity to gain familiarity with practical research problems and methods. Students gain experience working in collaborative research teams with a variety of researchers, focusing on problems of multiple scales, using techniques that go beyond those available at RIT. Note: Completion of Research Potential Assessment and adviser approval; permission of the Ph.D. Director are required. (Enrollment in this course requires permission from the department offering the course.) Co-op, Credits 0 (Fall, Spring, Summer)

CISC-899 Independent Study
PhD students will work with supervising faculty on a project or research study of mutual interest. The design and evaluation will be determined through discussion with the supervising faculty and documented through completion of an independent study form. The independent study must be approved by the PhD Director. Note: Permission of the instructor and Ph.D. Director is required. (Enrollment in this course requires permission from the department offering the course.) Lecture, Credits 1 - 6 (Fall, Spring, Summer)

Computing Security
CSEC-601 Research Methods and Proposal Development
It is important that students in this graduate program be able to perform in depth literature review, understand and apply different fundamental research methods in computing security areas. This course is designed to help students in this direction. Students will be encouraged to investigate the continuing computing security problems, that arise due to vulnerabilities in software and hardware, and malicious cyber-attacks by adversaries. This will provide the foundations for the student to decide on a project/thesis topic. Invited talks from faculty and members from other institution to share their research and scholarship work will seed such research thinking. Students will be encouraged to interact with faculty members to formulate their project/thesis topics and scope. Students will be expected to develop a research proposal that may serve as the basis for their later project/thesis proposal. In addition, this course provides an overview of the academic research methodologies used in graduate level work. Topics include but are not limited to: experimental research, correlation, experiment observation, surveys, and case studies. Also included will be document structure, validation, and the process for submission and review to conferences and journals. (This course is restricted to students in the COMPSEC-MS or NETSYS-MS programs.) Lecture, Credits 3 (Fall)

CSEC-603 Enterprise Security
This course is designed to provide students with the advanced concepts needed to establish network security strategies to ensure adequate protection for the corporate environment and yet provide accessibility for the corporate community. (This course is restricted to students in the COMPSEC-MS program.) Lecture, Credits 3 (Spring)

CSEC-604 Cryptography and Authentication
In this course, students will learn in depth knowledge of cryptography and authentication. Students will explore various cryptography algorithms, authentication protocols, and their design and implementation. Students will work on a project to implement a cryptographic algorithm and/or an authentication protocol. The applications of cryptography and authentications in the areas of computer networks and systems and information assurance will also be investigated. (This course is restricted to students in the COMPSEC-MS program.) Lecture, Credits 3 (Fall)

CSEC-699 Graduate Co-op
Students perform paid professional work related to the field of computing security. Students work full-time during the term for which they are registered. Students must complete a student co-op work report for each term for which they are registered; students are also evaluated each term by their employer. A satisfactory grade is given for co-op when both the student’s work report and the employer evaluation have been completed. Co-op is an optional part of the MS in Computing Security degree. (Enrollment in this course requires permission from the department offering the course.) Co-op, Credits 0 (Fall, Spring, Summer)
CSEC-730 Advanced Computer Forensics
This course provides students with the latest techniques and methods needed for extracting, preserving and analyzing volatile and nonvolatile information from digital devices. Students will gain exposure to the spectrum of available computer forensics tools along with developing their own tools for "special need" situations. The core forensics procedures necessary for ensuring the admissibility of evidence in court, as well as the legal and ethical implications of the process, will be covered on both Unix and Windows platforms, under multiple file systems. Therefore, students must possess a knowledge of available file systems on both platforms. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) Lecture 3, Credits 3 (Fall)

CSEC-731 Web Server and Application Security Audits
This course discusses the processes and procedures to perform a technical security audit of web servers and web based applications. Students will not only explore Web Servers and Applications/Services threats, but also apply the latest auditing techniques to identify vulnerabilities existing in or stemming from web servers and applications. Students will write and present their findings and recommendations in audit reports on web servers and application vulnerabilities. To be successful in this course students should be knowledgeable in a scripting language and comfortable with the administration of both Linux and Windows platforms. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) Lecture 3, Credits 3 (Spring)

CSEC-732 Mobile Device Forensics
Techniques and limitations related to the seizure and interrogation of a variety of digital devices will be explored. Various mobile phone and tablet platforms will be interrogated with the intent of gaining better access and understanding of the organization of data in the devices. The infusion of digital storage and identification devices such as MP3 players, RFID and tokens into our everyday lives requires the study of their weaknesses and forensic exploit-ability. As personal information is frequently gathered and stored on these devices, the loss of a device could adversely affect individuals and organizations. The examination, collection, and removal of such information will be studied. To be successful in this course students should be knowledgeable in basic networking, systems, and security technologies. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) Lecture 3, Credits 3 (Spring)

CSEC-733 Information Security Risk Management
This course will provide students with an introduction to the principle of risk management and its three key elements: risk analysis, risk assessment and vulnerability assessment. Students will also learn the differences between quantitative and qualitative risk assessment, and details of how security metrics can be modeled/monitored/controlled and how various types of qualitative risk assessment can be applied to the overall assessment process. Several industry case studies will be studied and discussed. Students will work together in teams to conduct risk assessments based on selected case studies or hypothetical scenarios. Finally, they will write and present their risk assessment reports and findings. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) Lecture 3, Credits 3 (Spring)

CSEC-741 Sensor and SCADA Security
This course is designed to provide students with knowledge of sensor network security with respect to practical implementations. In particular, secure sensor network design for Supervisor Control And Data Acquisition (SCADA) is discussed. SCADA encompasses technologies that manage and control much of the infrastructure that we depend on every day without realizing it. The failure or corruption of SCADA systems can not only be inconvenient but also hazardous when the resource is critical or life threatening. Securing SCADA systems is of great strategic importance. The role of sensor networks in SCADA is discussed and sensor security protocols for SCADA applications are evaluated and studied. To be successful in this course students should be knowledgeable in basic networking, systems, and security technologies. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) Lecture 3, Credits 3 (Spring)

CSEC-742 Computer System Security
The importance of effective security policies and procedures coupled with experience and practice is emphasized and reinforced through research and practical assignments. Organization and management of security discipline and response to threats is studied. Case studies of effective and failed security planning and implementation will be examined and analyzed. The issues influencing proper and appropriate planning for security and response to attacks will be studied. To be successful in this course students should be knowledgeable in networking, systems, and security technologies. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) Lab 2, Lecture 3, Credits 3 (Fall)

CSEC-743 Computer Viruses and Malicious Software
Computer malware is a computer program with malicious intent. In this course, students will study the history of computer malware, categorizations of malware such as computer viruses, worms, Trojan horses, spyware, etc. Other topics include, but are not limited to, basic structures and functions of malware, malware delivery mechanism, propagation models, anti-malware software, its methods and applications, reverse engineering techniques. Students will conduct research to understand the current state of the computer malware defense and offense. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) Lecture/Lab 3, Credits 3 (Fall)

CSEC-744 Network Security
Students will examine the areas of intrusion detection, evidence collection, network auditing, network security policy design and implementation as well as preparation for and defense against attacks. The issues and facilities available to both the intruder and data network administrator will be examined and evaluated with appropriate laboratory exercises to illustrate their effect. The students will be provided with an understanding of the principles and concepts of wired and wireless data network security. Students will perform a series of laboratory or homework experiments in order to explore various mechanisms for securing data networks including physical layer mechanisms, filters, applications and encryption. Students will engage in attack/defend scenarios to test their deployments against other teams. Students should be knowledgeable in networking technologies. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) Lecture 3, Credits 3 (Spring)

CSEC-750 Covert Communications
Students will be introduced to the history, theory, methodology and implementation of various kinds of covert communications. Students will explore future techniques and uses of covert communications. More specifically students will explore possible uses of covert communications in the management of botnets. To be successful in this course students should be knowledgeable in networking, systems, and security technologies. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) Lecture 3, Credits 3 (Fall)

CSEC-751 Information Security Policy and Law
This course explores Information Security Policy development and deployment as well as Laws (US and International) that impact Information Security. Students in this class will develop policies and analyze how policy impacts an organization. Students will also determine how Federal, State, and international laws impact the Information Security Policies of an organization. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) Lecture 3, Credits 3 (Fall)

CSEC-759 Graduate Seminar in Computing Security
This course explores current topics in Computing Security. It is intended as a place holder course for faculty to experiment new course offerings in Computing Security undergraduate program. Course specific details change with respect to each specific focal area proposed by faculty. Lecture/Lab 3, Credits 3 (Fall, Spring)

CSEC-770 MS Thesis
This course is a capstone course in the MS in Computing Security program. It offers students the opportunity to investigate a selected topic and make an original contribution which extends knowledge within the computing security domain. As part of their original work students will write and submit for publication an article to a peer reviewed journal or conference. Students must submit an acceptable proposal to a thesis committee (chair, reader, and observer) before they may be registered by the department for the MS Thesis. Students must defend their work in an open thesis defense and complete a written report of their work before a pass/fail grade is awarded. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 6 (Fall, Spring, Summer)

CSEC-771 MS Project
This course is a capstone course in the MS in Computing Security program. It offers students the opportunity to investigate a selected topic within the computing security domain. The student may complete a project for real world application in a laboratory environment. Students must submit an acceptable proposal to a project committee (chair, and reader) before they may be registered by the department for the MS Project. Students must defend their work in an open project defense and complete a written report of their work before a letter grade is awarded. (Enrollment in this course requires permission from the department offering the course.) Project, Credits 1 - 3 (Fall, Spring, Summer)

CSEC-773 Capstone for Computing Security
Students will apply their knowledge learned through the program to solve real world problems. Various areas of computing security. Large scale projects will be defined for students to work on throughout the semester. At the end of semester students will present their results and demonstrate their knowledge and skills in problem solving and critical thinking in a setting open to the public. (Enrollment in this course requires permission from the department offering the course.) Lecture, Credits 1 - 3 (Spring)
Information Sciences and Technologies

ISTE-600 **Analytical Thinking**
There is mounting evidence of a need to improve the ability of individuals and groups to think thoughtfully and analytically in order to develop appropriate and useful solutions to complex problems. Sources of complexity include human cognitive limitations, uncertainty, system dynamics, and reasoning errors. This course will provide students with frameworks, techniques, methods, and tools to improve analytical and critical thinking and presentation skills. Students will work individually and in groups on assignments and case study analyses. Note: One year of programming in a high-level language, one statistics course are needed. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-605 **Scholarship in Information Sciences and Technologies**
IT graduate students are expected to make a significant scholarly contribution as a requirement for the MS degree. The Scholarship in Information Sciences and Technologies course provides students with the fundamental skills needed to conduct a program of investigation related to participating in the degree capstone course, or in developing a capstone or thesis project. The course focuses on skills such as identifying interesting and important topics and problems, developing and articulating research questions and proposals, critical thinking, and effective oral and written communication and presentation of scholarship. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-608 **Database Design and Implementation**
This course provides an introduction to the theory and practice of designing and implementing database systems. Current software environments are used to explore effective database design and implementation concepts and strategies. Topics include conceptual data modeling, methodologies, logical/physical database design, normalization, relational algebra, schema creation and data manipulation, and transaction design. Database design and implementation projects are required. Note: One year of programming in an object-oriented language is needed. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) Lecture/Lab 4, Credits 3 (Fall)

ISTE-610 **Knowledge Representation Technologies**
This is the first course in a 2-course sequence that provides students with exposure to foundational information sciences and technologies. Topics include an overview of data types, structuring and processing data and knowledge, data transformation, and data storage and warehousing. Students will learn computational methods to manage large datasets in the context of specific problem scenarios. Note: One year of programming in an object-oriented language, a data theory course, and a Web development course is needed. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-612 **Knowledge Processing Technologies**
This is the second course in a 2-course sequence that provides students with exposure to foundational information sciences and technologies. Topics include Internet middleware technologies, data and text analytics, and information visualization. Note: One year of programming in an object-oriented language, a database theory course, a course in Web development, and a statistics course is needed. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-645 **Foundations of Web Technologies I**
This course provides an introduction to Internet and web technologies. Topics include an introduction to the Internet and basic Internet technologies (including, but not limited to: SSH, SFTP, UNIX, XHTML, CSS, Client-Side programming, and web site publishing). Note: One year of programming in an object-oriented language is needed. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-646 **Foundations of Web Technologies II**
This course builds on the basics of web page development that are presented in the first course and extends that knowledge to focus on issues and technologies related to the design and implementation of websites. Topics include advanced Internet technologies (including, but not limited to: AJAX, server-side programming, database use and access, client libraries, server frameworks, and creating and consuming information services). (Prerequisites: ISTE-645 or equivalent course and graduate standing in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Spring)

ISTE-699 **Graduate Co-op**
An optional cooperative educational experience is available to graduate students to add practical employment experience to their studies to support their career objectives and personal goals. Permission of Graduate program director is required. Note: Graduate standing with the IST department, and prerequisites plus at least 18 credits completed with a 3.0 GPA or better. (Enrollment in this course requires permission from the department offering the course.) Co-op, Credits 0 (Fall, Spring, Summer)

ISTE-722 **Database Connectivity and Access**
In this course, students will build applications that interact with databases. Through programming exercises, students will work with multiple databases and programmatically invoke the advanced database processing operations that are integral to contemporary computing applications. Students will examine and evaluate alternative approaches for each of these operations. Topics include the database drivers, the data layer, connectivity operations, security and integrity, and controlling database access. (Prerequisites: ISTE-608 or equivalent course and graduate standing in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-724 **Data Warehousing**
This course covers the purpose, scope, capabilities, and processes used in data warehousing technologies for the management and analysis of data. Students will be introduced to the theory of data warehousing, dimensional data modeling, the extract/transform/load process, warehouse implementation, dimensional data analysis, and summary data management. The basics of data mining and importance of data security will also be discussed. Hands-on exercises include implementing a data warehouse. (Prerequisites: ISTE-608 or equivalent course and graduate standing in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-726 **Database Management and Access**
Students will be introduced to issues in client/server database implementation and administration. Students will configure, test, and establish client-server communication and server-server communication with single and multiple database servers. Topics include schema implementation, storage allocation and management, user creation and access security, backup and recovery, and performance measurement and enhancement will be presented in lecture and experienced in a laboratory environment. Students will configure and demonstrate successful communication between a database file server and multiple clients. (Prerequisites: ISTE-608 or equivalent course and graduate standing in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-728 **Database Performance and Tuning**
Students will explore the theory and application of performance monitoring and tuning techniques as they relate to database systems. Standard topics in DBMS performance will be discussed including: physical and logical design issues, the hardware and software environment, SQL statement execution, and front-end application issues. Techniques in performance monitoring and tuning will be investigated. (Prerequisites: ISTE-726 or equivalent course and graduate standing in INFOST-MS or INFOTEC-MS.) Lecture/Lab 4, Credits 3 (Spring)

ISTE-740 **Geographic Information Science and Technology**
This course provides a survey of the theory, concepts, and technologies related to representation and understanding of the earth - a scientific domain known as Geographic Information Science and Technology (GIS & T). Students will gain hands-on experience with technologies such as Global Positioning Systems (GPSs), Geographic Information Systems (GISs), remote sensing, Virtual Globes (Google Earth), and web mapping mashups. Furthermore, students will learn relevant GIS & T theory, concepts, and research trends such as spatial reasoning, spatiotemporal data representation, and spatial analysis. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-742 **Introduction to Geographic Information Systems**
This course introduces students to the world of Geographic Information Systems (GIS). Course lectures, reading assignments, and practical lab experiences will cover a mix of conceptual, practical and technical GIS topics. Topics include GIS data models, basic cartography, geodatabases, spatial analysis, GIS software, and theory and concepts from the Geographic Information Science and Technology domain. (Prerequisites: ISTE-740 or equivalent course.) Lecture/Lab 3, Credits 3 (Spring)
ISTE-744 Thematic Cartography and Geographic Visualization
This course examines concepts and techniques associated with dynamic map construction, usage, and assessment. Specific topics include thematic cartography, geographic information visualization, sources of dynamic geographic information, developing animated and interactive maps, mapping mashup development, using maps as a means to support group work, usability of dynamic maps, and current geovisualization research areas. Development of a visualization prototype and an associated scholarly paper in an area related to thematic cartography and geographic visualization are required. Note: One course in a high level programming language is needed. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) Lecture/ Lab 3, Credits 3 (Spring)

ISTE-750 Internet Middleware Design and Implementation
This course provides students with an introduction to the design and implementation of Internet middleware application programming interfaces (APIs) and services. Topics include the blending of interactive and dynamic content from multiple servers and services utilizing data from heterogeneous sources, with a strong design focus on the needs of client software and human users which will utilize those services. Provides a practical and theoretical basis for the design & implementation of APIs & middleware, and for the design and development of custom servers and services built on top of existing frameworks (such as Apache/PHP). Emphasis is placed on fundamentals, concepts and standards. Exercises, programming, and projects are required. (Prerequisites: ISTE-612 or equivalent course and graduate standing in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-754 Client Design and Development
This course will explore the analysis, design, development, and implementation of client-side programming in the context of Internet technologies, mobile devices, and Web-based client systems. Students will learn to design and build usable and effective interactive systems, clients, and interfaces. Key features addressed will include browser and platform compatibility, object reusability, bandwidth and communications issues, development environments, privacy and security, and related technologies and APIs. Programming is required. (Prerequisites: ISTE-140 or equivalent course.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-756 Server Design and Development
This course provides students with advanced work in the design & implementation of highly-scalable Internet servers, and application programming interfaces (APIs). Topics include the effects of client requirements upon design, creating & blending heterogeneous data for analysis & visualization, and approaches to building highly-scalable services. Students will develop dynamic, data centric web systems, as well as building information services systems that are independent of the technologies that use them. Students will implement their own servers and services using programming languages. Exercises, programming, and projects are required. (Prerequisites: ISTE-754 or equivalent course.) Lecture/Lab 3, Credits 3 (Spring)

ISTE-758 Semantic Web Technologies
This course provides students with an in-depth introduction to Semantic Web technologies, utilizing ontologies and relationship metadata. Topics include the creation of data linkage through metadata, practical approaches to the design and implementation of ontologies, server- and client-side parsing and transformation of data and ontologies, and machine interpretation of relationships. Emphasis is placed on fundamentals, concepts and standards. Exercises, programming, and projects are required. (Prerequisites: ISTE-610 and ISTE-612 or equivalent courses and graduate standing in the INFOST-MS program.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-759 Web Client Server Programming
When building sophisticated web applications, Client and Server technologies are used together to create the best possible web-based applications. This course will explore the creation of such integrated applications, exploring topics such as dynamic creation of web technology based applications in a client-server environment. Programming projects are required. (Prerequisites: ISTE-754 and ISTE-756 or equivalent course and restricted to degree-seeking graduate students.) Lecture/Lab 3, Credits 3 (Fall, Spring)

ISTE-760 Design, Development, and Deployment of Applications
What’s the difference between writing an application for a school project and writing an application for mass marketing? What makes an application production-ready? In this course we will look at several factors that must be considered including help systems, installation routines, code design, and error handling. Students will need to have had one year of programming in a high-level language to be successful in this course. Lecture/Lab 3, Credits 3 (Fall)

ISTE-764 Project Management
Information technology projects require the application of sound project management principles in order to be developed on time, on budget, and on specification. This course takes students through the nine knowledge areas of modern project management and the utilization of project management principles in both traditional and agile environments. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) Lecture 3, Credits 3 (Fall)

ISTE-770 Foundations of Mobile Design
This course is an introduction to designing, prototyping, and creating applications and Web Apps for mobile devices. These devices include a unique set of hardware and communications capabilities, incorporate novel interfaces, are location aware, and provide persistent connectivity. Topics covered include user interaction patterns, connectivity, interface design, software design patterns, and application architectures. Programming projects are required and how these devices interact with the Internet of Things. Students will examine and evaluate alternative approaches and then implement in working applications. (Prerequisites: ISTE-754 or equivalent course.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-771 XML Programming
Exchange of information between disparate programs is a significant problem in industry. Students will learn how to leverage XML to achieve interoperability between software systems. Topics covered in this hands-on course include parsing and generating XML, the service-oriented paradigm, and the development and consumption of services. Assignments and projects will be programming intensive. Note: One year of programming in an object-oriented language is needed. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-772 Knowledge Discovery for Biomedical Informatics
This course will provide an in-depth exposure to advanced topics in biomedical informatics and knowledge discovery. Large datasets will be used to illustrate and explore methods in the transformation of data to information and integration of information with domain knowledge. Topics will include high-throughput technologies in genomics, descriptive and inferential statistics, machine learning, visualization, human-computer interaction. Note: One year of programming in an object-oriented language is needed. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Spring)

ISTE-773 XML Transformation and Presentation
This course will explore techniques and technologies for transforming XML documents using XSLT and XSL-FO or other frameworks. The emphasis will be on transformation of XML data into human-readable documents, such as HTML, pages and PDF files. Topics covered will include XSLT syntax and processing, XPath, and XSLT. Students will implement projects to present XML data using a variety of transformation tools and technologies. (Prerequisites: ISTE-610 or equivalent course.) Lecture/Lab 3, Credits 3 (Fall, Spring)

ISTE-774 Mobile Application Development I
Mobile Application Development I provides students with individual and team-based experience of creating interesting native applications for small-size form factor mobile devices such as smartphones using one of the major platforms. These devices are exceptionally portable, have unique sets of hardware and communications capabilities, incorporate novel interfaces, are location aware, and provide persistent connectivity. Students are encouraged to make creative use of these unique device characteristics and operating properties to develop innovative applications including inter-device communications. Programming projects are required. (Prerequisites: ISTE-770 or equivalent course.) Lecture/Lab 3, Credits 3 (Spring)

ISTE-776 Mobile Application Development II
This course extends the material covered in the Foundations of Mobile Design course and provides students with individual and team-based experience of creating interesting native applications for small-size form factor mobile devices such as slates and tablets and another major mobile operating system. Compared to smartphones, these devices have much larger screen areas, and have the potentials for more processing power, higher capacity memories, additional sensors, and higher capacity batteries. Students are encouraged to make creative use of these increased display and computing resources to develop innovative applications. Students will be required to expand on concepts covered in the course by investigating and implementing more advanced features not covered directly in the course. Programming projects are required. (Prerequisites: ISTE-770 or equivalent course.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-780 Data-Driven Knowledge Discovery
Rapidly expanding collections of data from all areas of society are becoming available in digital form. Computer-based methods are available to facilitate discovering new information and knowledge that is embedded in these collections of data. This course provides students with an introduction to the use of these data analytic methods within the context of the data-driven knowledge discovery process. Topics include motivations for data-driven discovery, sources of discoverable knowledge (e.g., data, text, the Web, maps), data selection and retrieval, data transformation, computer-based methods for data-driven discovery, and interpretation of results. Emphasis is placed on the application of knowledge discovery methods to specific domains. (Prerequisites: ISTE-600 and graduate standing in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Spring)
ISTE-782 Visual Analytics
This course introduces students to Visual Analytics, or the science of analytical reasoning facilitated by interactive visual interfaces. Course lectures, reading assignments, and practical lab experiences will cover a mix of theoretical and technical Visual Analytics topics. Topics include analytical reasoning, human cognition and perception of visual information, visual representation and interaction technologies, data representation and transformation, production, presentation, and dissemination of analytic process results, and Visual Analytic case studies and applications. Furthermore, students will learn relevant Visual Analytics research trends such as Space, Time, and Multivariate Analytics and Extreme Scale Visual Analytics. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Fall)

ISTE-790 Thesis in Information Sciences and Technologies
The thesis capstone experience for the Master of Science in Information Sciences and Technologies program. Students must submit an approved capstone proposal in order to enroll. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 6 (Fall, Spring, Summer)

ISTE-791 Project in Information Sciences and Technologies
The project-based culminating experience for the Master of Science in Information Sciences and Technologies program. A MS project will typically include a software system development component requiring a substantial and sustained level of effort. Students must submit an approved project proposal in order to enroll. (Enrollment in this course requires permission from the department offering the course.) Project, Credits 1 - 4 (Fall, Spring, Summer)

ISTE-792 Capstone Guidance Colloquium
This course supports the proposal development process for graduate students enrolled in the MS in Information Sciences and Technologies, the MS in Networking and System Administration, or the MS in Human-Computer Interaction program who are beginning the project or thesis experience and require additional structure and support. Students begin the development of an acceptable proposal and through weekly meetings students are guided toward the completion of the proposal, which is a prerequisite for formal thesis or project registration. Note: Students must have completed all their course work prior to enrollment which is by permission of the graduate program director. Lecture 1, Credits 1 (Fall, Spring, Summer)

ISTE-795 Capstone in Information Sciences and Technologies
This is the project-based capstone course for the Master of Science in Information Sciences and Technologies program. Students work in teams to complete a substantial, integrative, large scale system development projects. Submission of a project proposal, a formal set of development artifacts, a final project report, and a public defense with system demonstration are required. (Enrollment in this course requires permission from the department offering the course.) Lecture/Lab, Credits 3 (Fall, Spring, Summer)

ISTE-798 Graduate Seminar in Information Sciences and Technologies
This IST seminar course provides an opportunity for special one-time offerings of graduate topics or allows faculty to pilot possible new graduate offerings. Specific course details (such as the course topics, format, resource needs, and credit hours) will be determined by the faculty member(s) who propose a given seminar offering. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) Lecture/Lab 3, Credits 3 (Fall, Spring, Summer)

ISTE-799 Independent Study
The student will work independently, under the supervision of one or more faculty advisors, on a topic of mutual interest that is beyond the depth of or not covered in other courses. (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1 - 3 (Fall, Spring, Summer)

ISTE-909 Proposal Development
This course supports the proposal development process for graduate students who are beginning the thesis experience. Students begin the development of an accepted proposal as a prerequisite for formal thesis registration. (Enrollment in this course requires permission from the department offering the course.) Research, Credits 0 (Fall, Spring, Summer)

HCIN-600 Research Methods
This course provides students with an introduction to the practical application of various research methods that can be used in human computer interaction. The course provides an overview of the research process and the literature review, and provides initial study in survey research and experimental research methods. Students will analyze several existing research studies and design and conduct studies. Students will need to have taken a statistics course before registering for this class. (This course is reserved for students in HUMCOMP-MS or AEEPSYC-MS.) Lecture 3, Credits 3 (Fall)

HCIN-610 Foundations of Human-Computer Interaction
Human-computer interaction (HCI) is a field of study concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them. This course surveys the scope of issues and foundations of the HCI field: cognitive psychology, human factors, interaction styles, user analysis, task analysis, interaction design methods and techniques, and evaluation. This course will focus on the users and their tasks. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall, Summer)

HCIN-620 Information and Interaction Design
Designing meaningful relationships among people and the products they use is both an art and a science. This course will focus on the unique design practice of: representing and organizing information in such a way as to facilitate perception and understanding (information architecture); and, specifying the appropriate mechanisms for accessing and manipulating task information (interaction design). This course will also explore the various design patterns (design solutions to particular problems) that are appropriate for the HCI professional. Students will need prior knowledge of an interface prototyping tool. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall)

HCIN-630 usability Testing
This project-based course will focus on the formal evaluation of products. Topics include: usability test goal setting, recruitment of appropriate users, design of test tasks, design of the test environment, test plan development and implementation, analysis and interpretation of the results, and documentation and presentation of results and recommendations. (Prerequisites: HCIN-600 and HCIN-610 or equivalent courses.) Lecture 3, Credits 3 (Spring)

HCIN-636 Interactive Programming
This course teaches students how to program interactive components to create user interfaces and information visualization systems. Students will work with data, information, animation, and digital media to create interactive applications. Students will be introduced to visual layout and design concepts. Programming is required. Students will need to have taken one year of programming in a high-level language to be successful in this course. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture/ Lab 3, Credits 3 (Fall)

HCIN-660 Fundamentals of Instructional Technology
Instructional Technology encompasses the basic processes for developing and delivering instruction. Instructional Systems Design (ISD) is a well-established methodology for describing knowledge and skills and developing instructional systems to effectively conveying knowledge. This course enables the student to be able to plan, organize, and systematically develop instructional materials. The course uses an ISD model to analyze, design, deliver, and evaluate instruction. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall)

HCIN-661 Interactive Courseware
Computer software that teaches is referred to as courseware. This course is a continuation of HCIN-660 that transitions from “general” Instructional Design into the actual application of these principles in a computer-based environment. Although the basic principles of instructional design hold true in all media environments, using these teaching and learning principles is somewhat different when developing instruction that will be delivered by computer. This course teaches procedures that have already been successful in the design and development of courseware. Successful students should have one year of object-oriented programming. (Prerequisites: HCIN-660 or equivalent course HCIN-660 Prereq) Lecture 3, Credits 3 (Spring)

HCIN-700 Current Topics in HCI
Human-Computer Interaction (HCI) is an evolving field. This course is designed to study the current themes and advanced issues of HCI. Topics will vary depending upon current research and developments in the field. Lecture 3, Credits 3 (Spring)

HCIN-705 Topics in HCI for Biomedical Informatics
This course will provide a theoretical and case-based study of several areas of HCI, all considered within the application domain of biomedical informatics. Course topics include: A Scientific Approach to UI design (Usability Engineering), Domain-Specific User Analysis & User Profiles, Social and Cultural Influences, General and Domain-Specific Design Issues, Information Visualization, Data Integration, Mobile Devices, Security, Privacy and Ethics. (Prerequisites: HCIN-610 or equivalent course.) Lecture 3, Credits 3 (Spring)

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HCIN-715 Agent-Based and Cognitive Modeling
This course is intended as an introduction to the emerging areas of Agent-Based Modeling and Cognitive Modeling. Both modeling approaches are at the intersection of research (theory development and confirmation) and computational simulation. This course will be an introduction to these topics, focusing on the research aspects of agent-based modeling and the development and testing of cognitive models. The role of visualization in modeling development and analysis is presented. Students will analyze the social science literature for current models and theories and will develop computational models incorporating these theories. (Prerequisites: HCIN-600 or equivalent course.) Lecture/Lab 3, Credits 3 (Spring)

HCIN-720 Designing User Experiences for Internet-enabled Devices
With the emergence of devices like touch-screens, smartphones, tablet/slate computers, and Internet-connected appliances like large-screen televisions, a new set of skills and knowledge in designing user experiences is required. Applications and Apps which target users on smartphones and tablets cannot just be based on miniaturizing the desktop experience; they require re-thinking the design patterns and best practices applied to devices. Students will learn to design, prototype, and develop user experiences aimed at use of these new classes of devices. (Prerequisites: HCIN-620 or equivalent course.) Lecture 3, Credits 3 (Spring)

HCIN-722 Human Computer Interaction with Mobile Devices
With the emergence of mobile devices such as smartphones and tablet/slate computers as well as software technologies such as gesture-based interfaces and augmented reality, new possibilities for human computer interaction have emerged and new skills and knowledge in designing human computer interactions is required. Students will learn to design and implement human computer interactions utilizing these devices and their unique capabilities. (Prerequisites: HCIN-720 or equivalent course.) Lecture 3, Credits 3 (Spring)

HCIN-725 Human Computer Interaction
This course will focus on the major user centered design methodologies used in the development of applications and environments. Topics include: evolution of software design methods, emergence of user-centered design, and key concepts, attributes and process of the major design methodologies. Software design projects will be required. (Prerequisites: HCIN-610 or equivalent course.) Lecture 3, Credits 3 (Spring)

HCIN-730 User-Centered Design Methods
This course focuses on several research areas that have been developed in the area of user-centered design, including: design and evaluation of user interfaces; human-computer interaction; and usability testing. The course will explore the theoretical foundations of user-centered design and the practical aspects of designing, building, and evaluating interactive systems. Students will gain hands-on experience in designing and evaluating user interfaces through a series of projects and case studies. (Prerequisites: HCIN-600 or equivalent course.) Lecture 3, Credits 3 (Spring)

HCIN-735 Collaboration, Technology, and the Human Experience
Students will examine the role of technology and group collaboration in organizations. An overview of relevant theory, current and emergent technologies, and trends in collaborative science will provide the context for strategic implementation and development of collaborative environments. Group projects using collaborative technologies will be required. (Prerequisites: HCIN-600 and HCIN-610 or equivalent courses.) Lecture 3, Credits 3 (Spring)

HCIN-795 MS HCI Project
In this course, students will apply the theories and methodologies to the investigation of a problem in the HCI domain. Students working individually or in teams, through the guidance of the instructor, will investigate a problem space, perform a literature review, develop the problem statement, design and implement a solution, and communicate the results. Permission of a capstone committee and graduate program director is required. (Enrollment in this course requires permission from the department offering the course.) Project, Credits 1 - 4 (Fall, Spring, Summer)

HCIN-796 MS HCI Thesis
Students electing a research capstone experience will work closely with an adviser on a current research project or one self-developed and guided by the adviser. Permission of the capstone committee and the graduate program director is required. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 6 (Fall, Spring, Summer)

HCIN-909 Proposal Development
This course is part of a capstone experience for graduate students who are just beginning the thesis topic development process. Students must submit an accepted proposal as a prerequisite for formal thesis work. Requires permission of the program director for enrollment. (Enrollment in this course requires permission from the department offering the course.) Research, Credits 0 (Fall, Spring, Summer)

MEDI-610 Scripting Fundamentals
This course is an introductory scripting course. Students will learn to design software solutions using the procedural approach, to implement software solutions using a contemporary programming language, and to test these software solutions. Topics include problem definitions, designing solutions, implementing solutions using a contemporary programming language, implementing a contemporary library/framework, and testing software solutions. Programming projects will be required. Lecture/Lab 3, Credits 3 (Fall)

MEDI-701 Introduction to Medical Informatics
This course provides a rigorous introduction to the principles of medical informatics. The focus of this course is on the study of the nature of medical information and its use in clinical practice and clinical quality improvement. Key topics include: the electronic medical record (EMR) and its impact on health care delivery; the information system as source of medical information, Healthcare Information Systems, the software development lifecycle, the importance of the informatics specialists in medicine and the various roles they can play, and government economic incentives and policy issues in healthcare such as privacy, confidentiality, including health care regulatory and accreditation issues and the Health Insurance Portability and Accountability Act (HIPAA). Students will participate in online discussion of medical informatics. They will also investigate several topics of interest in the field and provide presentations. (Taught at University of Rochester) (MEDINFO-MS) Lecture 3, Credits 3 (Fall)

MEDI-702 Perspectives of Health Informatics
The health care industry is composed of many different disciplines, specialties, and professions. Designing and developing informatics solutions requires an understanding of the roles, approaches and information needs of the many diverse user groups in delivering health care services for patients and health populations. This course will focus on the overlapping and divergent requirements of a comprehensive electronic health record from the perspectives of patients, health care providers (physicians, nurses, pharmacists, etc), health care payers, public health structures, biotechnology firms and researchers. Group projects will be required. (Taught at University of Rochester) (Prerequisites: MEDI-701 or equivalent course and graduate standing in the MEDINFO-MS program.) Lecture 3, Credits 3 (Fall)

MEDI-704 Practice of Health Care
This course is an introduction to clinical practice for graduate students in Medical Informatics. It consists of the study of six medical specialties including shadowing of clinicians in these areas. Students in this course will be part of a team of health care professionals in the selected specialties. They will round with providers, assist with information gathering and dissemination, and observe specialty specific disease process, diagnosis and treatment. They will observe and note clinical workflow and technology usage. They will interact with team members and assist with the acquisition of reference knowledge as appropriate. They will keep a log of cases during the rotation and use this as the basis for their research project and case presentation. (Taught at University of Rochester) (Prerequisites: MEDI-701 or equivalent course and graduate standing in the MEDINFO-MS program.) Lecture 3, Credits 3 (Spring)

MEDI-705 Medical Knowledge Structures
This course presents concepts related to organization and retrieval of knowledge-based information in the health sciences. It includes a study of classification schemes, controlled vocabularies and thesauri, metadata, and ontologies. Major schemes and systems examined, for example, include MeSH, UMLS, and PubMed. Also covered are the topics of knowledge retrieval at the point of care, and knowledge discovery. (Taught at University of Rochester) (Prerequisites: MEDI-701 or equivalent course and graduate standing in the MEDINFO-MS program.) Lecture 3, Credits 3 (Spring)

MEDI-707 Clinical Decision Support
This course provides a rigorous introduction to the principles of modeling and implementing decision support systems. It begins with an overview of how to frame a clinical or health care management question, develop a decision support model, and find appropriate evidence for model calibration. The major decision categories covered in the course for clinical practice include those regarding treatment, diagnosis, harm (etiology), and prognosis. The major decision categories covered in the course for health care management include service provision, resource allocation, and cost-effectiveness. The course will identify the best types of evidence to answer questions, and how to find and apply that evidence. The decision support modeling techniques include game theory, Bayesian theory, decision trees, planning models, systems dynamics models, and queuing models. The course concludes with a section on summarizing evidence (e.g., through systematic reviews and meta-analysis), putting evidence into practice (e.g., implementing clinical practice guidelines), and the limitations of the approaches covered in the course. Students will apply decision support techniques in addressing real world problems using appropriate software and participate in online discussion of decision analysis in the medical literature. (Taught at University of Rochester) (Prerequisites: MEDI-701 or equivalent course and graduate standing in the MEDINFO-MS program.) Lecture 3, Credits 3 (Fall)

MEDI-711 Introduction to US Health Care System
In this course, we examine the organization, financing, delivery, and performance of the U.S. health care system. The inherent tradeoffs between access to care, cost, quality, and outcomes are considered from the perspective of the main actors in the system, i.e. patients, providers (physicians, hospitals, etc.), health plans, insurers and payers. Topics include: need and access to care; health care insurance and financing; Medicare and Medicaid; managed care; service delivery; long-term care; public health; quality of care, and others. The aim of the course is to help students deepen their understanding of the health care system, strengthen their ability to synthesize the literature and assess key current policy issues, and to further develop their critical thinking skills. (Taught at University of Rochester course) (Enrollment in this course requires permission from the department offering the course.) Lecture 3, Credits 3 (Fall)
**Medical Application Integration**  
A typical hospital information system architecture contains a variety of best of breed applications running on different hardware and software platforms. Exchange of information between these applications can be a significant problem. In this course, students will learn how to leverage the loose coupling of service-oriented architectures and message oriented middleware to address the issues of data integration between these types of computer programs when executing across domains. Programming projects will be required. (Students will need a database theory course, and one year of object-oriented programming to be successful in this course)  
(Prerequisites: MEDI-701 or equivalent course and graduate standing in the MEDIINFO-MS program.) Lecture/Lab 3, Credits 3 (Fall)

**System Integration Concepts**  
This course will provide students with an understanding of application integration concepts in healthcare. Students will also learn medical business processes and how they impact data integration within a healthcare setting. Middleware message brokers will be examined along with the use of the HL7 messaging standard. Web services and other forms of data integration will be studied. Students will develop integration solutions to support healthcare information systems exchange and validation processes and solutions to ensure the quality of information exchanged between healthcare systems. Lecture 3, Credits 3 (Fall)

**Healthcare Systems**  
A study of the component approach to clinical information systems. Students will learn about the evolution of Health Information Systems, and the variety of systems offered by vendors at the present time. The importance of the Electronic Health Record (EHR), the Computerized Physician Order Entry (CPOE) and Clinical Decision Support will be stressed as they become the focal points in clinical information systems. The following components will be studied in detail: patient, activity, health record, knowledge, and security components. The role of imaging management and integration will also be reviewed. (Prerequisites: MEDI-701 or equivalent course and graduate standing in the MEDIINFO-MS program.) Lecture/Lab 3, Credits 3 (Spring)

**Building the Electronic Health Record**  
This course explores the acquisition, storage, and use of information in the electronic health record (EHR) through hands-on development and programming. Students will learn about the types of information used in clinical care: text, structured data, images, and sounds. Other topics covered include: clinical vocabularies (existing schemes and their limitations); how clinical information is generated and utilized; methods of information storage and retrieval; departmental systems (laboratory, radiology, and hospital information systems); organizational systems (including scheduling, registration and financial systems); and the legal, social and regulatory problems of EHRs including security and confidentiality. (Prerequisites: HCIN-610 and MEDI-705 or equivalent courses and graduate standing in the MEDIINFO-MS program.) Lecture/Lab 3, Credits 3 (Fall)

**Capstone in Health Informatics**  
This team-based course provides students with the opportunity to apply the knowledge and skills learned in coursework to design, develop, and implement a solution to a real problem in the medical informatics domain. Project teams also will be responsible for submitting a final project report, and for making a final presentation to project stakeholders. (Completion of first year courses) (Enrollment in this course requires permission from the department offering the course.) Lecture 3, Credits 3 (Fall)

**Proposal Development**  
This course is part of a capstone experience for graduate students who are beginning the capstone experience. Students will submit an accepted proposal as a prerequisite for the formal thesis. Permission of the Graduate Adviser is required. (Enrollment in this course requires permission from the department offering the course.) Research, Credits 0 (Fall, Spring, Summer)

**Game Design**  
This course presents students with core theories of game design, informed by research results from media theory, narrative methods and models, theories of ideation, and the nature of games, play and fun. Specific emphasis is placed on the examination of historical successes and failures, along with presentation of ethical and cultural issues related to the design of interactive software. Students will engage in formal critique and analysis of media designs and their formal elements. (This course is restricted to students in the GAMEDES-MS program.) Lecture/Lab 3, Credits 3 (Fall)

**Gameplay and Prototyping**  
This course explores the pragmatic issues of creative concept development through story-boarding, prototyping and play-testing. Students will use various tools and techniques to build game prototypes that they will evaluate through play-testing in an incremental design process informed by market research and analysis. (This course is restricted to students in the GAMEDES-MS program.) Lecture/Lab 3, Credits 3 (Fall)

**Digital Audio Production**  
Technologies and techniques for producing and manipulating digital audio are explored. Topics include digital representations of sound, digital audio recording and production, MIDI, synthesis techniques, real-time performance issues, and the application of digital audio to multimedia and Web production. (This course is restricted to students in the GAMEDES-MS program.) Lecture/Lab 3, Credits 3 (Fall)

**Interactive Game and Audio**  
This course provides students with exposure to the design, creation and production of audio in interactive applications and computer games. Students will become familiar with the use of sound libraries, recording sounds in the studio and in the field, generating sound with synthesizers, and effects processing. Students will create sound designs for interactive media, integrating music, dialog, ambient sound, sound effects and interface sounds within interactive programs. (This course is restricted to students in the GAMEDES-MS program.) Lecture/Lab 3, Credits 3 (Spring)

**Game Design and Development for Casual and Mobile Platforms**  
This course explores the design and development of casual and mobile game applications. Students will begin by exploring the design practices relevant to casual and mobile games, including hardware constraints, player expectations, play experiences, mechanics for casual and mobile experiences, as well as the aesthetics and presentation of casual and mobile game elements. As students learn the theoretical concepts, they will also learn the development process for casual and mobile games. Development topics will include technology platforms, physical and logical interface control, graphics and interaction, tools and APIs, connectivity, data management, data persistence, delivery mechanisms, and systems integration with desktop and web-based platforms. (This course is restricted to students in the GAMEDES-MS program.) Lecture/Lab 3, Credits 3 (Spring)
IGME-740  Game Graphics Programming
Students will explore the use of an advanced graphics API to access hardware-accelerated graph-ics in a real-time graphics engine context. The course will involve discussion of scene graphs, optimizations, and integration with the API object structure, as well as input schemes, content pipelines, and 2D and 3D rendering techniques. Students will also explore the advanced use of the API calls in production code to construct environments capable of real-time performance. Students will construct from scratch a fully functional graphics engine, with library construction for game development. Advanced topics will be explored, including real-time special effects, custom shading pipelines, and advanced deferred rendering techniques. (Prerequisites: IGME-601 or equivalent courses.) Lecture/Lab 3, Credits 3 (Spring)

IGME-750  Game Engine Design and Development
This course will provide students with theory and practical skills in game engine design topic areas such as understanding the graphics pipeline as it influences engine design, hardware principles and the relationship to game engine construction, mathematical principles involved in game engine design, scene graph construction and maintenance, texture and materials management, collision systems, physics systems, particle systems, and control systems. Furthermore, this course will examine software and tools that assist game engine designers in their tasks. Students will be expected to design and implement a game engine in teams as well as properly document their design and development strategy. (This course is restricted to students in the GAMES-MS program.) Lecture/Lab 3, Credits 3 (Fall)

IGME-760  Artificial Intelligence for Gameplay
This course explores artificial intelligence concepts and research through both a theoretical perspective and a practical application to game development. In particular the course focuses on AI concepts and paradigms such as search and representation, reasoning under uncertainty, intelligent agents, biologically inspired computing and machine learning to real-time situations and applications as relevant to the field of entertainment technology and simulation. (This course is restricted to students in the GAMES-MS program.) Lecture/Lab 3, Credits 3 (Fall)

IGME-788  Capstone Design
This course allows students within the Game Design and Development program to develop a capstone proposal and design document. The capstone design document specifies the scope and depth of the capstone project. In addition, it defines the group and individual responsibilities for the cohort capstone project experience. Lecture 3, Credits 3 (Fall)

IGME-789  Capstone Development
This course provides Master of Science in Game Design and Development students with capstone project experiences. Students are expected to work in cohorts towards the implementation of a game system that properly illustrates proficiency in the application of theory and practice towards a large-scale project. For each student, individual responsibilities for the group project will be defined in consultation with both the group and the faculty. Students must successfully complete the Capstone Design course and present a satisfactory capstone project proposal to the faculty before enrolling in this course. (Prerequisites: IGME-788 or equivalent course and graduate standing in GAMES-MS.) Lecture/Lab 3, Credits 3 (Spring)

IGME-790  Graduate Seminar in IGME
This is intended to allow for special one-time offerings of graduate topics. Specific course details (such as the course topics, format, resource needs, and credit hours) will be determined by the faculty member(s) who propose a given seminar offering. (This course is restricted to students in the GAMES-MS program.) Lecture/Lab, Credits 1 - 6 (Fall, Spring, Summer)

IGME-795  Game Industry Themes and Perspectives
This required course prepares students for a career in the field of game design and development. Students will attend lectures by and discussions with RIT faculty and visitors and participate in student project experiences. Students will be expected to design and implement a game engine in teams as well as properly document their design and development strategy. (This course is restricted to students in the GAMES-MS program.) Lecture/Lab 2, Credits 1 (Fall)

IGME-796  Advanced Topics in Game Design
This course examines current topics in Game Design. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. (This course is restricted to students in the GAMES-MS program.) Lecture/Lab 3, Credits 3 (Fall, Spring, Summer)

IGME-797  Advanced Topics in Game Development
This course examines current topics in Game Development. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. (This course is restricted to students in the GAMES-MS program.) Lecture/Lab 3, Credits 3 (Fall, Spring, Summer)

IGME-799  Independent Study
The student will work independently under the supervision of a faculty adviser on a topic not covered in other courses. (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1 - 6 (Fall, Spring, Summer)

Networking, Security and Systems Administration
NSSA-602  Enterprise Computing
This course explores enterprise systems (clouds, server farms, mainframes, and clusters/grid) from the environment, networking, storage, security, and system administration perspectives. Students in this course gain an understanding of the knowledge and concepts needed to manage, perform research in, and administrate those architectures. (This course is restricted to students in the NETPLN-AC or NETSYS-MS programs.) Lecture 3, Credits 3 (Fall)

NSSA-605  Principles of System Admin
Students are introduced to fundamental system administration topics and technologies that serve as the basis for later course work in system administration. Topics covered include: ethics and system administration, the law and system administration, and the role of the system administrator in organizations. Technologies covered include: computing resource management, the TCP/IP protocol suite, the Domain Name Service (DNS), the Dynamic Host Configuration Protocol (DHCP), and web services hosting. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall, Spring)

NSSA-610  Advanced Wired Networking Concepts
This course will cover the principles of wired networking with a focus on algorithms, protocols and implementation of advanced wired networking concepts. The course will begin with in-depth background in architecture and protocols at a physical, MAC, IP, and transport layers. Also, theoretical aspects of wired network challenges are discussed with a research focus. The course also explores the realm of wired technologies such as peer-to-peer networks, future internet, real-time applications, smart grid and IPv4 and IPv6 integration and translation. Students will learn about these technologies through lectures and explore some of them through a class project. (This course is restricted to NETSYS-MS Major students.) Lecture 3, Credits 3 (Fall)

NSSA-611  Advanced Topics in Wireless Networks and Technologies
The course is designed to provide comprehensive exposition to the challenges faced in wireless networks and technologies in the different protocol layers. Leading work conducted to address the challenges faced in the new techniques such as cross layered and integrated approaches will be covered. From the challenges perspective, case studies based on several upcoming wireless technologies and networks will be presented. In most cases, the standards efforts follow the deployment, which lags the research effort. Some of the standardization efforts and their impacts in industry deployment and the effect of research on standardization will be covered. This study will be based on case studies. Students will need one statistics course to be successful in this class. (This course is restricted to NETSYS-MS Major students.) Lecture 3, Credits 3 (Spring)

NSSA-612  Network Modeling and Analysis
The course provides comprehensive exposition of the core concepts in network modeling and simulation. It will cover both graph theoretical and statistical models of complex networks such as the Internet and social networks. It also introduces different types of modeling techniques and simulation tools. The course also systematically addresses some practical and theoretical considerations for developing complex modeling. It offers real world examples to illustrate the process of modeling to address specific problems. Students will need one statistics course to be successful in this class. (This course is restricted to NETSYS-MS Major students.) Lecture 3, Credits 3 (Spring)

NSSA-621  Design and Deployment of Wireless Networks
This course will take students through large scale wireless systems. It will also cover the significant access wireless networks. Important areas of concern will be contemporary and emerging WLAN standards, cellular communication and other forms of wireless access such as wireless Internet service provision. Focal points for these areas will be protocol operation, network architecture and security concerns. (This course is restricted to NETSYS-MS Major students.) Lecture 3, Credits 3 (Spring)

NSSA-622  Carrier Networking
This course is primarily concerned with the issues associated with carrier networks in the WAN. Major protocols such as BGP, MPLS, T carriers, Metro Ethernet and SONET will form the backbone of the content. In addition to protocol architecture and operation, the course will also examine the integrated nature of these protocols as they support contemporary communication applications. (This course is restricted to NETSYS-MS Major students.) Lecture 3, Credits 3 (Spring)
NSSA-710 Network Management
This course provides an introduction to network management concepts with hands-on laboratory sessions in developing network management applications and using it to study and analyze the performance of networks, data communications hardware and software, and use of these components in computer networks. Topics include but are not limited to introduction to network management concepts, the five basic network management functions namely fault management, configuration management, performance management, accounting management and security management; introduction to SNMP and its versions; remote monitoring and different network management architectures. (This course is restricted to NETSYS-MS Major students.) Lecture/Lab 3, Credits 3 (Fall)

NSSA-711 Advanced Routing Protocols
Managing complex network environments requires an understanding of the sophisticated routing protocols necessary for controlling information flow. This course will examine the routing protocols in standard use and their application in typical enterprise and large internet service provider (ISP) environments. The advantages and disadvantages of each protocol will be investigated. In addition, emerging wired and wireless routing protocols will also be discussed. Knowledge of networking, systems, and security technologies is necessary. (This course is restricted to NETSYS-MS Major students.) Lecture 3, Credits 3 (Fall)

NSSA-712 Advanced Storage Technologies
Data storage is an integral and essential component of every computer system. This course explores the spectrum of storage technologies ranging from DAS to JBODS to SANs. Media types including Ramdisk, Flash, SSD, magnetic, optical and other emerging technologies will be investigated. The issues to be faced as systems grow to enterprise scale will also be addressed. Features of local, distributed, and networked storage including SANs will be introduced as well as issues such as capacity planning, virtualization, decentralized storage, security, crash recovery and load balancing, and maintenance in support of high performance systems and maintenance. Knowledge of networking, systems, and security technologies is necessary. (This course is restricted to NETSYS-MS Major students.) Lecture 3, Credits 3 (Fall)

NSSA-713 Enterprise Service Provisioning
Advances in server software and hardware have made it possible for large organizations to consolidate software services onto fewer, higher powered servers while at the same time enhancing reliability and availability. This course will explore available technologies such as cluster computing and server virtualization as they can be used to deploy software services in enterprise environments. (This course is restricted to NETSYS-MS Major students.) Lecture 3, Credits 3 (Spring)

NSSA-714 Advanced Large-Scale Computing
This course explores, in depth, large-scale systems (mainframes, clouds, clusters/grids) from an advanced perspective in the environment, networking, storage, security, and system administration topics. Students in this course gain the ability needed to design and justify, perform research in, and administer these enterprise-scale systems. (This course is restricted to NETSYS-MS Major students.) Lecture 3, Credits 3 (Spring)

NSSA-715 Network Design and Performance
This course will examine the design and performance of networks. Students will learn to design networks based on identified needs and analyze the performance of that network. The designs include site, campus, and enterprise networks. WAN technologies will be combined with LAN technologies in the design of enterprise networks. Students will learn to assess the business goals and their application to the network goals. Students will learn to evaluate the security goals of the network and to integrate these goals in the design. (Prerequisites: NSSA-602 or equivalent course.) Lecture 3, Credits 3 (Spring)

NSSA-716 Enterprise Mobile Computing
This course will cover technologies for web-based mobile computing, especially for business solutions. The course covers enterprise mobile computing architecture, emerging mobile computing technologies, operating system, and security. Also, the course discusses different applications of mobile computing in mobile ad-hoc and sensor networks. Knowledge of networking, systems, and security technologies is necessary. (This course is restricted to NETSYS-MS Major students.) Lecture 3, Credits 3 (Spring)

NSSA-789 GraduateSeminarInNetworkingandSystemAdministration
This IST seminar course provides an opportunity for special one-time offerings of graduate topics or allows faculty to pilot possible new graduate offerings. Specific course details (such as the course topics, format, resource needs, and credit hours) will be determined by the faculty member(s) who propose a given seminar offering. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture/Lab 3, Credits 3 (Fall, Spring, Summer)
B. Thomas Golisano College of Computing and Information Sciences

SWEN-722 Process Engineering
In this course, students will study various lifecycle models for developing software systems. They will study the Software Process Engineering Metamodel (SPEM) standard as a tool for modeling and analyzing engineering processes. Students will use SPEM to characterize various process and organization models and patterns, and they will align these process characteristics to categories of needs for various organizations and projects. The students will study process engineering frameworks and the configuration and assembly of reusable process components into processes. Students will also study how tools and methods support the process. Students will also study software process assessment models, including the Capability Maturity Models, and learn how to identify specific recommendations for an organization to improve their processes. Students will apply their learning to engineer software engineering processes, tools, and methods appropriate for their graduate projects, course projects, and projects for organizations they have worked for. Lecture/Lab 3, Credits 3 (Spring)

SWEN-745 Software Modeling
Modeling plays a pivotal role during the software lifecycle during the pre-construction and post-construction activities of the software lifecycle. During the pre-construction stage, models help software engineers understand, specify, and analyze software requirements and designs. During the post-construction stage, models can be used to analyze software systems while in operation. This kind of analysis includes reliability and safety issues as well as timing constraint analysis. (Department approval) (SOFTENG-MS) Lecture/Lab 3, Credits 3 (Fall)

SWEN-749 Software Evolution and Reengineering
This course explores the concepts of software evolution and reengineering and introduces approaches and support tools used to extract the information needed to assess existing software systems. Major maintenance activities are presented including estimating maintenance costs, managing change and predicting maintainability with software quality metrics. Organizational issues relative to product maintenance are discussed. Principles of software reuse and reverse engineering techniques are demonstrated through the use of class activities, team projects and case studies. (Prerequisites: SWEN-745 or equivalent course.) Lecture/Lab 3, Credits 3 (Spring)

SWEN-772 Software Quality Engineering
This course begins with an exploration of the concepts underlying quality systems and the use of metrics. Students are encouraged to discuss the advantages as well as the limitations of systems and quantitative approaches, with a view to understanding the 40 importance of interpretation in metrics usage and of matching quality systems choices to organizational objectives and culture. They learn the use of modern metrics such as DRE, PCE, COQ/COPQ, reliability objectives and SUMI scores through exercises in analyzing and interpreting charts. This is complemented with a project where they work in teams to design an appropriate quality system for a specific project/organizational situation, and discuss the application and analysis of its evaluation experimentation as a means of improving the quality aspects of subject project/organizational situation. (Prerequisites: SWEN-722 or equivalent course.) Lecture/Lab 3, Credits 3 (Fall)

SWEN-781 Continuation of Capstone
This course provides the student with an opportunity to complete their capstone project, if extra time if needed after enrollment in 790. The student continues to work closely with his/her adviser. (Department Approval) (Enrollment in this course requires permission from the department offering the course.) Continuation, Credits 0 (Fall, Spring, Summer)

SWEN-789 Graduate Special Topics
This course will cover specialized topics in software engineering. Such topics are often considered emerging and advanced. Graduate Standing and specific prerequisites will be noted upon specific proposal of a course. (SOFTENG-MS) Lecture/Lab 3, Credits 3 (Fall, Spring, Summer)

SWEN-790 Thesis
This course provides the student with an opportunity to execute a thesis project, analyze and document the project in thesis document form. An in-depth study of a software engineering topic will be research focused, having built upon the thesis proposal developed prior to this course. The student is advised by their primary faculty adviser and committee. The thesis and thesis defense is presented for approval by the thesis adviser and committee. (Department Approval) (Enrollment in this course requires permission from the department offering the course.) Thesis 3, Credits 6 (Fall, Spring, Summer)

SWEN-791 Continuation of Thesis
This course provides the student with an opportunity to complete their thesis project once having enrolled in both thesis courses (794, 795), if extra time if needed. The student continues to work closely with his/her advisor and thesis committee.(Department Approval) (Enrollment in this course requires permission from the department offering the course.) Continuation, Credits 0 (Fall, Spring, Summer)
Graduate Course Descriptions

Kate Gleason College of Engineering

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Course numbering: RIT courses are generally referred to by their alphanumeric registration label. The Four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100-299), upper division (300-599), or graduate level (600 and above).

Unless otherwise noted, the following courses are offered annually. Specific times and dates can be found in each semester’s schedule of courses. Prerequisites/corequisites are noted in parentheticals near the end of the course description.

General Engineering

ENGR-701 Interdisciplinary Research Methods
This course emphasizes collaboration in modern research environment and consists of five modules. Students will be introduced to the concepts of inter-disciplinary and trans-disciplinary research conducted from both a scientific and an engineering perspective. Students will learn how to write a dissertation proposal, statement of work, timeline for their program of study and the elements of an effective literature review. Students will develop skills related to reviewing and annotating technical papers, conducting a literature search and proper citation. Students will demonstrate an understanding of (a) ethics as it relates to the responsible conduct of research, (b) ethical responsibility in the context of the engineering professions, (c) ethics as it relates to authorship and plagiarism, (d) basic criteria for ethical decision making and (e) identify professional standards and code of ethics relevant to their discipline. Students demonstrate an ability to identify and explain the potential benefits of their research discoveries to a range of stakeholders, including policy makers and the general public. Lecture 3, Credits 3 (Fall)

ENGR-702 Translating Discovery into Practice
This course provides graduate students with the professional skills needed by PhD graduates within their major research area to move the results of their research from the lab into practice. Students will demonstrate a strong contextual understanding for their research efforts. Students will learn professional skills related to Teamwork; Innovation, Entrepreneurship and Commercialization; Research Management; Policy and Societal Context; and Technical Writing. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Spring)

ENGR-703 Engineering Analysis
This course trains students to utilize mathematical techniques from an engineering perspective, and provides essential background for success in graduate level studies. An intensive review of linear and nonlinear ordinary differential equations and Laplace transforms is provided. Laplace transform methods are extended to boundary-value problems and applications to control theory are discussed. Problem solving efficiency is stressed, and to this end, the utility of various available techniques are contrasted. The frequency response of ordinary differential equations is discussed extensively. Applications of linear algebra are examined, including the use of eigenvalue analysis in the solution of linear systems and in multivariate optimization. An introduction to Fourier analysis is also provided. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall, Spring)

ENGR-704 Advanced Engineering Mathematics
Advanced Engineering Mathematics provides the foundations for complex functions, vector calculus and advanced linear algebra and its applications in analyzing and solving a variety of electrical engineering problems especially in the areas of control, circuit analysis, communication, and signal/image processing. Topics include: complex functions, complex integration, special matrices, vector spaces and subspaces, the nullspace, projection and subspaces, matrix factorization, eigenvalues and eigenvectors, matrix diagonalization, singular value decomposition (SVD), functions of matrices, matrix polynomials and Cayley-Hamilton theorem, state-space modeling, optimization techniques, least squares technique, total least squares, and numerical techniques. Electrical engineering applications will be discussed throughout the course. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall, Spring)

ENGR-795 Doctoral Seminar
This seminar course presents topics of contemporary interest to graduate students enrolled in the program. Presentations include off campus speakers, and assistance with progressing on your research. Selected students and faculty may make presentations on current research under way in the department. All doctoral engineering students enrolled full time are required to attend each semester they are on campus. (Graduate standing in a technical discipline) (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Seminar 1, Credits 1 (Fall, Spring)

ENGR-877 Doctoral Internship
Internship is designed to enhance the educational experience of PhD students through full-time employment. Students must submit a proposal for the internship, to be approved by an employing supervisor and the department prior to enrolling. Students are required to submit an evaluation report at the conclusion of the internship. (This course is restricted to students in the MCSE-PHD or ENGR-PHD program.) INT 3, Credits 0 (Fall, Spring, Summer)

ENGR-890 Dissertation and Research
Doctoral-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. Students must successfully pass the PhD Candidacy examination prior to enrolling in this course Research 3, Credits 1 - 6 (Fall, Spring, Summer)

ENGR-892 Graduate Research
Doctoral-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. Students may count a maximum of 9 credits of ENGR-892 towards degree requirements. If the student enrolls cumulatively in more than 9 credits of ENGR-892, the additional credits above 9 will not be counted towards the degree. Research 3, Credits 1 - 6 (Fall, Spring, Summer)

ENGR-899 Independent Study
This course is used by students who plan to study a topic on an independent study basis. The student and instructor must prepare a plan of study and method of evaluation for approval by the program director prior to course registration. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Independent Study 3, Credits 3 (Fall, Spring, Summer)

Computer Engineering

CMPE-610 Analytical Topics in Computer Engineering
This course begins by reviewing signal and system analysis techniques for analyzing linear systems. It includes Fourier techniques and moves on to present fundamental computational techniques appropriate for a number of applications areas of computer engineering. Other topics include symbolic logic and optimization techniques. (Prerequisites: CMPE-480 and MATH-251 or 1016-345) or graduate standing in the CMPE-MS program.) Lecture, Credits 3 (Fall, Spring)

CMPE-630 Digital Integrated Circuit Design
This course will cover the basic theory and techniques of Digital Integrated Circuit Design in CMOS technology. Topics include CMOS transistor theory and operation, design and implementation of CMOS circuits, fabrication process, layout and physical design, delay and power models, static and dynamic logic families, testing and verification, memory and nanoscale technologies. Laboratory assignments and project facilitate in hands-on learning of circuit-level design and simulation, layout and parasitic extractions, pre and post-layout verification and validation, full-custom flow and Synthesis based flow, using industry standard CAD tools. (Prerequisites: CMPE-280 and EECE-381 or equivalent courses or graduate standing in the CMPE-MS program.) Lab, Lecture, Credits 3 (Fall, Spring)

CMPE-640 Control Systems
This course introduces students to the study of linear control systems, their behavior and design and use in augmenting engineering system performance. This is accomplished through classical control methods that employ the use of Laplace transforms, block diagrams, root locus, and frequency domain diagrams. Topics include: Laplace transform review, system modeling for control, fundamentals of time response behavior, stability analysis, steady-state error and design, feedback, control properties, PID control, root locus analysis and design, and frequency response design. Lecture 3, Credits 3 (Spring)
CMPE-655 Multiple Processor Systems
The course introduces basic concepts of parallel and high-performance computing and current methodologies and trends in the design and programming of multiprocessor systems. Theoretical models of parallel computing and performance metrics are studied and contrasted with practical parallel system architectures, programming environments, and benchmarking techniques. Parallel architectures are classified according to mode and degree of parallelism, memory organization, and type and typology of interconnection networks used in the design. The suitability of various architectures in meeting demands is studied in depth including the study of representative examples of current commercial machines. Students will complete programming assignments on a parallel computer illustrating practical issues. A review and analysis of a commercial parallel processor system or an active research area is required; written review presented in class. (Prerequisite: CMPE-550 or equivalent course or graduate standing in the CMPE-MS program.) Lecture, Credits 3 (Fall, Spring)

CMPE-660 Reconfigurable Computing
The objective of this course is to present the foundations of reconfigurable computing methodologies from both hardware and software perspectives. Topics covered are: architectures of modern field programmable gate arrays (FPGAs), digital system design methodologies using FPGAs, hardware-software co-design with embedded processors, hardware optimization techniques, system level integration under operating system, dynamic reconfiguration. Laboratory projects in which students will acquire a solid capability of Xilinx CAD tools and FPGA devices are required. The projects include the whole design flow: design of the system, VHDL modeling, software and hardware development, FPGA verification. (Prerequisites: CMPE-260 or equivalent course or graduate standing in the CMPE-MS program.) Lab, Lecture, Credits 3 (Fall)

CMPE-661 Hardware and Software Design for Cryptographic Applications
The objective of this course is to build knowledge and skills necessary for efficient implementations of cryptographic primitives on reconfigurable hardware. The implementation platform will be a field programmable gate array (FPGA) containing a general purpose processor and additional reconfigurable fabric for implementations of custom hardware accelerators. In the studio format, team projects require design of selected cryptographic primitives followed by comparison and contrast of various implementation alternatives, such as software, custom FPGA hardware, and hybrid hardware-software co-design. Project teams are ideally composed of one Computer Engineering student and one Software Engineering or Computer Science student. Computer Engineering students lead the hardware design portions of each project, and Software Engineering and Computer Science students lead the software development portions. Topics may include binary field arithmetic, block ciphers, hash functions, counter mode of operation for block ciphers, public key cryptosystems, hardware/software co-design methodologies with FPGAs, software development and profiling, high level synthesis, on-chip buses, hardware/software interfaces, custom hardware accelerators and side channel attacks. (Prerequisites: CMPE-260 or CMPE-240 or equivalent course or graduate standing in the CMPE-MS program.) Studio 2, Credits 3 (Spring)

CMPE-663 Real-time and Embedded Systems
This first course in a graduate elective sequence will begin by presenting a general road map of real-time and embedded systems. The course will be conducted in a studio class/lab format with lecture material interspersed with laboratory work. This course will introduce a representative family of microcontrollers that will exemplify unique positive features as well as limitations of microcontrollers in embedded and real-time systems. These microcontrollers will then be used as external, independent performance monitors of more complex real-time systems. The majority of the course will present material on a commercial real-time operating system and using it for programming projects on development systems and embedded target systems. Some fundamental material on real-time operating systems and multiprocessor considerations for real-time systems will also be presented. Examples include scheduling algorithms, priority inversion, and hardware-software co-design. (Prerequisites: CMPE-380 and SWEN-220 or equivalent courses or graduate standing in the CMPE-MS program.) Lecture, Credits 3 (Fall)

CMPE-664 Modeling of Real-Time Systems
This course introduces the modeling of real-time software systems. It takes an engineering approach to the design of these systems by analyzing system models before beginning implementation. UML will be the primary modeling methodology. Non-UML methodologies will also be discussed. Implementations of real-time systems will be developed manually from the models and using automated tools to generate the code. (Prerequisite: SWEN-220 or CSCI-251 or CMPE-380 or graduate standing in the CMPE-MS program.) Lecture 3, Credits 3 (Spring)

CMPE-665 Performance Engineering of Real-Time and Embedded Systems
This course discusses issues of performance in real-time and embedded systems. Techniques for profiling the resource usage of a system and for measuring the effect of increasing system requirements will be covered. The control of physical systems will motivate the need for performance tuning of a real-time system. Students will write programs running under a real-time operating system that can maintain control of a physical system. The course will discuss and experiment with performance trade-offs that can be made using hardware-software co-design. (Prerequisite: SWEN-220 or CSCI-251 or CMPE-380 or graduate standing in the CMPE-MS program.) Lecture 3, Credits 3 (Fall)

CMPE-667 Data and Communication Networks
This course will give an overview of the technologies, architectures and protocols used to build various types of computer and communication networks - wired or wireless. The emphasis will be placed on discussions of various network design problems and solution approaches. Specific issues covered in this course include: framing and coding, error detection, multiple access control, addressing, routing, flow and congestion control, scheduling and switching. (Prerequisite: MATH-251 or 1016-345 or graduate standing in the CMPE-MS program.) Lecture,Credits 3 (Fall, Spring)

CMPE-670 Robotics: Embedded and Autonomous Systems
This course covers an overview of robotics topics with an AI influence. Includes hands-on laboratory with low level microcontroller programming driving a Lynxmotion 4WD chassis. Course has a strong emphasis on robotics related input and output device interfacing. Course topics include microcontrollers, control systems, vision, path planning localization, and machine learning. Term project of student choosing emphasizes a specific robotic topic. (Prerequisites: CMPE-380, CMPE-460 and CMPE-480 or equivalent courses or graduate standing in the CMPE-MS program.) Lab 2, Lecture 3, Credits 3 (Summer)

CMPE-680 Digital Image Processing Algorithms
Emphasizes both theory and implementation of image processing algorithms. Two-dimensional filtering, sampling, and transforms are introduced and used for image enhancement, compression, restoration, segmentation, and applications in color and video processing. Project assignments involve Matlab implementation of algorithms and paper reviews. (Prerequisites: CMPE-480 or equivalent course or graduate standing in the CMPE-MS program.) Lecture 3, Credits 3 (Fall)

CMPE-685 Computer Vision
This course covers both fundamental concepts and the more advanced topics in Computer Vision. Topics include image formation, color, texture and shape analysis, linear filtering, edge detection and segmentation. In addition, students are introduced to more advanced topics, such as model based vision, object recognition, digital image libraries and applications. Homework, literature reviews and programming projects are integrated with lectures to provide a comprehensive learning experience. (Prerequisites: CMPE-480 or equivalent course or graduate standing in the CMPE-MS program.) Lecture, Credits 3 (Spring)

CMPE-699 Advanced Digital Integrated Circuit Design
This course covers techniques for high-performance, low power and reliability in digital integrated circuit design from a systems perspective. Emphasis will be on the most important design challenges, being the impact of scaling, interconnect, signal integrity, power and timing. Presentation and term paper based on current research articles is required. Laboratory assignments are based on real time applications. Design process starting from logic synthesis down to layout synthesis will be covered in the laboratory, with industry standard CAD tools. (Prerequisites: CMPE-530 or CMPE-630 or equivalent course.) Lab, Lecture, Credits 3 (Spring)

CMPE-731 Design and Test of Multi-Core Chips
Massive levels of integration following Moore’s Law is making modern multi-core chips all-pervasive in several domains ranging from scientific applications like weather forecasting, astronomical data analysis, bioinformatics applications to even consumer electronics. This course introduces students to current and future trends in IC Design. Students learn to identify bottlenecks in designing state-of-the-art multicore System-on-Chips (SoCs) and propose solutions to such design challenges from a cross-layer perspective spanning multiple levels of abstraction in the design process. Low-power and high-speed testing of multicore chips is an important design issue in Design for Testability (DFT) of such massive multicore systems. In this course students learn various issues and solutions to ongoing challenges in SoC testing. The instruction will rely on lectures, textbooks, seminal and cutting edge publication articles and term projects. Students will be evaluated based on homework assignments, class presentations, examinations and projects. (Prerequisites: CMPE-530 or CMPE-630 or equivalent course.) Lecture 3, Credits 3 (Fall)
**Electrical Engineering**

**EEE-602 Random Signals and Noise**
In this course the student is introduced to random variables and stochastic processes. Topics covered are probability theory, conditional probability and Bayes theorem, discrete and continuous random variables, distribution and density functions, moments and characteristic functions, functions of one and several random variables, Gaussian random variables and the central limit theorem, estimation theory, random processes, stationarity and ergodicity, auto correlation, cross-correlation and power spectrum density, response of linear prediction, Wiener filtering, elements of detection, matched filters. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture, Credits 3 (Fall, Spring)

**EEE-605 Modern Optics for Engineers**
This course provides a broad overview of modern optics in preparation for more advanced courses in the rapidly developing fields of optical fiber communications, image processing, super-resolution imaging, optical properties of materials, and novel optical materials. Topics covered: geometrical optics, propagation of light, diffraction, interferometry, Fourier optics, optical properties of materials, polarization and liquid crystals, and fiber optics. In all topics, light will be viewed as signals that carry information (data) in the time or spatial domain. After taking this course, the students should have a firm foundation in classical optics. (Prerequisite: EEEE-374 or equivalent course.) Lecture, Credits 3 (Spring)

**EEE-610 Analog Electronics**
This is a foundation course in analog integrated electronic circuit design and is a prerequisite for the graduate courses in analog integrated circuit design EEEE-726 and EEEE-730. The course covers the following topics: (1)CMOS Technology (2) CMOS active and passive element models (3) Noise mechanisms and circuit noise analysis (4) Current mirrors (5) Differential amplifiers, cascode amplifiers (6) Multistage amps and common mode feedback (7) Stability analysis of feedback amplifiers; (8) Advanced current mirrors, amplifiers, and comparators (9) Band gap and translinear cells (10) Matching. (Prerequisites: EEEE-482 or equivalent course or graduate standing in EEEE-MS.) Lecture, Credits 3 (Fall)

**EEE-620 Design of Digital Systems**
The purpose of this course is to expose students to complete, custom design of a CMOS digital system. It emphasizes equally analytical and CAD based design methodologies, starting at the highest level of abstraction (RTL, front-end), and down to the physical implementation level (back-end). In the lab students learn how to capture a design using both schematic and hardware description languages, how to synthesize a design, and how to custom layout a design. Testing, debugging, and verification strategies are formally introduced in the lecture, and practically applied in the lab projects. Students are further required to choose a research topic in the area of digital systems, perform bibliographic research, and write a research paper following a prescribed format. (Prerequisites: EEEE-420 or equivalent course or graduate standing in EEEE-MS.) Lab, Lecture, Credits 3 (Fall)

**EEE-621 Design of Computer Systems**
The purpose of this course is to expose students to the design of single and multicore computer systems. The lectures cover the design principles of instructions set architectures, non-pipelined data paths, control unit, pipelined data paths, hierarchical memory (cache), and multicore processors. The design constraints and the interdependencies of computer systems building blocks are being presented. The operation of single core, multicore, vector, VLIW, and EPIC processors is explained. In the first half of the semester, the lab projects enforce the material presented in the lectures through the design and physical emulation of a pipelined, single core processor. This is then being used in the second half of the semester to create a multicores computer system. The importance of hardware/software co-design is emphasized throughout the course. Students are further required to choose a research topic in the area of computer systems, perform bibliographic research, and write a research paper following a prescribed format. (Prerequisites: EEEE-420 or equivalent course or graduate standing in EEEE-MS.) Lab, Lecture, Credits 3 (Fall)

**EEE-625 Lab Applications in Mechatronics**
This course provides a culminating experience for the mechatronics engineering certificate, relying upon the completed course work and culminating in development of laboratory experiences related to mechatronics. Students enrolled in the course will design and prepare a novel lab experiment and complete lab experiments created by peers. (BS in Engineering) (Prerequisites: EEEE-451 or equivalent course.) Lab 1, Lecture 2, Credits 3
EEE-629
Antenna Theory
The primary objective is to study the fundamental principles of antenna theory applied to the analysis and design of antenna elements and arrays including synthesis techniques and matching techniques. Topics include antenna parameters, linear antennas, array theory, wire antennas, microstrip antennas, antenna synthesis, aperture antennas and reflector antennas. A significant portion of the course involves design projects using some commercial EM software such as Ansoft Designer, Ansoft HFSS and SONNET and developing Matlab codes from theory for antenna synthesis and antenna array design. The measurement of antenna input and radiation characteristics will be demonstrated with the use of network analyzers, and spectrum analyzers in an anechoic chamber. (Prerequisites: EEEE-374 or equivalent course or graduate standing in EEEE-MS.) Lecture, Credits 3 (Fall)

EEE-636
Biorobotics/Cybernetics
Cybernetics refers to the science of communication and control theory that is concerned especially with the comparative study of automatic control systems (as in the nervous system and brain and mechanical-electrical communications systems). This course will present material related to the study of cybernetics as well as the aspects of robotics and controls associated with applications in a biological nature. Topics will also include the study of various paradigms and computational methods that can be utilized to achieve the successful integration of robotic mechanisms in a biological setting. Successful participation in the course will entail completion of at least one project involving incorporation of these techniques in a biomedically applied. Students are required to write an IEEE conference paper on their projects. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lab, Lecture, Credits 3 (Spring)

EEE-647
Artificial Intelligence Explorations
The course will start with the history of artificial intelligence and its development over the years. There have been many attempts to define and generate artificial intelligence. As a result of these attempts, many artificial intelligence techniques have been developed and applied to solve real life problems. This course will explore variety of artificial intelligence techniques, and their applications and limitations. Some of the AI techniques to be covered in this course are intelligent agents, problem-solving, knowledge and reasoning, uncertainty, decision making, learning (Neural networks and Bayesian networks), reinforcement learning, swarm intelligence, Genetic algorithms, particle swarm optimization, applications in robotics, controls, and communications. Students are expected to have any of the following programming skills listed above. Students will write an IEEE conference paper. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture, Credits 3 (Fall)

EEE-661
Modern Control Theory
This course deals with a complete description of physical systems its analysis and design of controllers to achieve desired performance. The emphasis in the course will be on continuous linear systems. Major topics are: state space representation of physical systems, similarities/differences between input-output representation (transfer function) and state space representations, conversion of one form to the other, minimal realization, solution of state equations, controllability, observability, design of control systems for desired performance, state feedback, observers and their realizations. (Co-requisites: EEEE-707 or equivalent course.) Lecture, Credits 3 (Fall)

EEE-663
Real-Time and Embedded Systems
This first course in a graduate elective sequence will begin by presenting a general road map of real-time and embedded systems. The course will be conducted in a studio class/lab format with lecture material interspersed with laboratory work. This course will introduce a representative family of microcontrollers that will exemplify unique positive features as well as limitations of microcontrollers in embedded and real-time systems. These microcontrollers will then be used as external, independent performance monitors of more complex real-time systems. The majority of the course will present material on a commercial real-time operating system and using it for programming projects on development systems and embedded target systems. Some fundamental material on real-time operating systems and multiprocessor considerations for real-time systems will also be presented. Examples include scheduling algorithms, priority inversion, and hardware-software co-design. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall)

EEE-664
Performance Engineering of Real Time and Embedded Systems
This course discusses issues of performance in real-time and embedded systems. Techniques for profiling the resource usage of a system and for measuring the effect of increasing system requirements will be covered. The control of physical systems will motivate the need for performance tuning of a real-time system. Students will write programs running under a real-time operating system that can maintain control of a physical system. The course will discuss and experiment with performance trade-offs that can be made using hardware-software co-design. (Prerequisites: EEEE-663 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

EEE-665
Modeling of Real Time Systems
This course introduces the modeling of real-time software systems. It takes an engineering approach to the design of these systems by analyzing system models before beginning implementation. UML will be the primary modeling methodology. Non-UML methodologies will also be discussed. Implementations of real-time systems will be developed manually from the models and using automated tools to generate the code. (Prerequisites: EEEE-663 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

EEE-669
Fuzzy Logic and Applications
In this course students are introduced to fuzzy systems and their applications in areas like control systems, signal and image processing, communications etc. Major topics are: Fuzzy sets and set operations. Evaluations of the rule sets using different implications, composition, aggregation and defuzzification methods. Applications in control systems: Development of fuzzy logic controllers for both linear and nonlinear systems & analysis and simulation studies of the designed systems. Function approximation using fuzzy systems. Students are also required to search published research works in other application areas like signal/image processing, communication, pattern recognition etc. and present their results to the class. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture, Credits 3 (Fall)

EEE-670
Pattern Recognition
This course provides a rigorous introduction to the principles and applications of pattern recognition. The topics covered include maximum likelihood, maximum a posteriori probability, Bayesian decision theory, nearest-neighbor techniques, linear discriminant functions, and clustering. Parameter estimation and supervised learning as well as principles of feature selection, generation and extraction techniques, and utilization of neural nets are included. Applications to face recognition, classification, segmentation, etc. are discussed throughout the course. (Prerequisites: EEEE-602 and EEEE-707 and EEEE-709 or equivalent courses.) Lecture, Credits 3 (Spring)

EEE-678
Digital Signal Processing
In this course, the student is introduced to the concept of multi rate signal processing, Poly phase Decomposition, Transform Analysis, Filter Design with emphasis on Linear Phase Response, and Discrete Fourier Transforms. Topics covered are: Z-Transforms, Sampling, Transform Analysis of Linear Time Invariant Systems, Filter Design Techniques, Discrete Fourier Transforms (DFT), Fast Algorithms for implementing the DFT including Radix 2, Radix 4 and Mixed Radix Algorithms, Quantization Effects in Discrete Systems and Fourier Analysis of Signals. (Prerequisites: EEEE-602 and EEEE-707 and EEEE-709 or equivalent courses.) Lecture, Credits 3 (Fall, Summer)

EEE-685
Principles of Robotics
An introduction to a wide range of robotics-related topics, including but not limited to sensors, interface design, robot devices applications, mobile robots, intelligent navigation, task planning, coordinate systems and positioning image processing, digital signal processing applications on robots, and controller circuitry design. Pre-requisite for the class is a basic understanding of signals and systems, matrix theory, and computer programming. Software assignments will be given to the students in robotic applications. Students will prepare a project, in which they will complete software or hardware design of an industrial or mobile robot. There will be a two-hour lab additional to the lectures. Students are required to write an IEEE conference paper on their projects. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lab, Lecture, Credits 3 (Fall)

EEE-689
Fundamentals of MEMS
Microelectromechanical systems (MEMS) are widely used in aerospace, automotive, biotechnology, instrumentation, robotics, manufacturing, and other applications. There is a critical need to synthesize and design high performance MEMS which satisfy the requirements and specifications imposed. Integrated approaches must be applied to design and optimized MEMS, which integrate microelectromechanical motion devices, ICs, and microsensors. This course covers synthesis, design, modeling, simulation, analysis, control and fabrication of MEMS. Synthesis, design and analysis of MEMS will be covered including CAD. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture, Credits 3 (Fall)

EEE-692
Communication Networks
This course covers communication networks in general and the internet in particular. Topics include layers service models, circuit and packet switching, queuing, pipelining, routing, packet loss and more. A five-layer model is assumed and the top four levels are covered in a top-down approach: starting with the application layer, going down through the transport layer to the network layer and finally the data link layer. Emphasis is placed on wireless networks and network security. Students would perform a basic research assignment consisting of a literature survey, performance analysis and dissemination of results in written and oral presentation. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture, Credits 3 (Spring)
Lecture 3, Credits 3 (Fall, Spring, Summer)

Digital Data Communication
Principles and practices of modern digital data communication systems. Topics include pulse code transmission and error probabilities, M-ary signaling and performance, AWGN channels, band-limited and distorting channels, filter design, equalizers, optimal detection for channels with memory, synchronization methods, non-linear modulation, and introduction to multipath fading channels, spread spectrum and OFDM. Students would perform a basic research assignment consisting of a literature survey, performance analysis and dissemination of results in written and oral presentation. (Prerequisites: EEEE-602 or equivalent course.) Lecture, Credits 3 (Fall)

EEE-707 Engineering Analysis
This course trains students to utilize mathematical techniques from an engineering perspective, and provides essential background for success in graduate level studies. An intensive review of linear and nonlinear ordinary differential equations and Laplace transforms is provided. Laplace transform methods are extended to boundary-value problems and applications to control theory are discussed. Problem solving efficiency is stressed, and to this end, the utility of various available techniques are contrasted. The frequency response of ordinary differential equations is discussed extensively. Applications of linear algebra are examined, including the use of eigenvalue analysis in the solution of linear systems and in multivariable optimization. An introduction to Fourier analysis is also provided. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture 3, Credits 3 (Fall, Spring, Summer)

EEE-709 Advanced Engineering Mathematics
Advanced Engineering Mathematics provides the foundations for complex functions, vector calculus and advanced linear algebra and its applications in analyzing and solving a variety of electrical engineering problems especially in the areas of control, circuit analysis, communication, and signal/image processing. Topics include: complex functions, complex integration, special matrices, vector spaces and subspaces, the nullspace, projection and subspaces, matrix factorization, eigenvalues and eigenvectors, matrix diagonalization, singular value decomposition (SVD), functions of matrices, matrix polynomials and Cayley-Hamilton theorem, state-space modeling, optimization techniques, least squares technique, total least squares, and numerical techniques. Electrical engineering applications will be discussed throughout the course. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture 3, Credits 3 (Fall, Spring, Summer)

EEE-711 Advanced Carrier Injection Devices
A graduate course in the fundamental principles and operating characteristics of carrier-injection-based semiconductor devices. Advanced treatments of pn junction diodes, metal-semiconductor contacts, and bipolar junction transistors form the basis for subsequent examination of more complex carrier-injection devices, including tunnel devices, transferred-electron devices, thyristors and power devices, light-emitting diodes (LEDs), and photodetectors. Topics include heterojunction physics and heterojunction bipolar transistors (HBT). (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture, Credits 3 (Spring)

EEE-712 Advanced Field Effect Devices
An advanced-level course on MOSFETs and submicron MOS devices. Topics include MOS capacitors, gated diodes, long-channel MOSFETs, subthreshold conduction and off-state leakage, short-channel effects, hot-carrier effects, MOS scaling and advanced MOS technologies. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture, Credits 3 (Spring)

EEE-713 Solid State Physics
An advanced-level course on solid-state physics, with particular emphasis on the electronic properties of semiconductor materials. Topics include crystal structure, wave propagation in crystalline solids, lattice vibrations, elements of quantum mechanics, elements of statistical mechanics, free-electron theory of metals, Boltzmann transport equation, quantum-mechanical theory of carriers in crystals, energy band theory, equilibrium carrier statistics, excess carriers in semiconductors, carrier transport. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture, Credits 3 (Fall)

EEE-718 Design and Characterization of Microwave Systems
There are two primary course objectives. Design of experiments to characterize or measure specific quantities, working with the constraints of measurable quantities using the vector network analyzer, and in conjunction with the development of closed form analytical expressions. Design, construction and characterization of microstrip circuitry and antennas for specified design criteria obtaining analytical models, using software tools and developing measurement techniques. Microwave measurement will involve the use of network analyzers, and spectrum analyzers in conjunction with the probe station. Simulated results will be obtained using some popular commercial EM software for the design of microwave circuits and antennas. (Prerequisites: EEEE-617 and EEEE-629 or equivalent course.) Lecture, Credits 3 (Fall)

EEE-720 Advanced Topics in Digital Systems Design
In this course the student is introduced to a multitude of advanced topics in digital systems design. It is expected that the student is already familiar with the design of synchronous digital systems. The lecture introduces the operation and design principles of asynchronous digital systems, synchronous and asynchronous, pipelined and wave pipelined digital systems. Alternative digital processing paradigms are then presented: data flow, systolic arrays, networks-on-chip, cellular automata, neural networks, and fuzzy logic. Finally, digital computer arithmetic algorithms and their hardware implementation are covered. The projects reinforce the lectures material by offering a hands-on development and system level simulation experience. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture 3, Credits 3 (Spring)

EEE-721 Advanced Topics in Computer System Design
In this course the student is introduced to advanced topics in computer systems design. It is expected that the student is already familiar with the design of a non-pipelined, single core processor. The lectures cover instruction level parallelism, limits of the former, thread level parallelism, multicore processors, optimized hierarchical memory design, storage systems, and large-scale multiprocessors for scientific applications. The projects reinforce the lectures material, by offering a hands-on development and system level simulation experience. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture, Credits 3 (Spring)

EEE-726 Mixed-Signal IC Design
This is the first course in the graduate course sequence in analog integrated circuit design EEEE-726 and EEEE-730. This course covers the following topics: (1)Fundamentals of data conversion (2) Nyquist rate digital-to-analog converters (3) Quantization noise and analysis (4) Nyquist rate analog-to-digital converters (5) Sample and hold circuits (6) Voltage references (7) Static and dynamic testing of digital-to-analog converters (8) Cell based design strategies for integrated circuits (9)Advanced topics in data conversion. (Prerequisites: EEEE-510 or EEEE-610 or equivalent course.) Lecture, Credits 3 (Spring)

EEE-730 Advanced Analog IC Design
This is the second course in the graduate course sequence in analog integrated circuit design EEEE-726 and EEEE-730. This course covers the following topics: (1) Fundamentals of Filter Design (2) Filter Approximations (3) Frequency and Impedance Scaling (4) Delay Equalization (5) Sensitivity Analysis (6) Sampled Data Theory (7) CMOS Integrated Filters including Switched Capacitor and gm-C Filters (8)Phase Locked Loops (Prerequisites: EEEE-726 or equivalent course.) Lecture, Credits 3 (Fall)

EEE-731 Integrated Optical Devices and Systems
This course discusses basic goals, principles and techniques of integrated optical devices and systems, and explains how the various optoelectronic devices of an integrated optical system operate and how they are integrated into a system. Emphasis in this course will be on planar passive optical devices. Topics include optical waveguides, optical couplers, micro-optical resonators, surface plasmons, photonic crystals, modulators, design tools and fabrication techniques, and the applications of optical integrated circuits. Some of the current state-of-the-art devices and systems will be investigated by reference to journal articles. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall)

EEE-733 Robust Control
This course will provide an introduction to the analysis and design of robust feedback control systems. Topics covered: overview of linear algebra and linear systems, H2 and H\infty spaces, modeling and paradigms for robust control; internal stability; nominal performance (asymptotic tracking); balanced model reduction; uncertainty and robustness; H2 optimal control; H\infty control; H\infty loop shaping; controller reduction; and design for robust stability and performance. (Prerequisites: EEEE-661 or equivalent course.) Lecture, Credits 3 (Spring)

EEE-766 Multivariable Modeling
This course introduces students to the major topics, methods, and issues in modeling multiple-input multiple-output (MIMO) linear systems. The course covers methods of creating models and refining them. Modeling topics include model-order determination, canonical forms, numerical issues in high-order models, creating frequency-response models from time-domain measurements, creating state-space models from frequency-response data, model-order reduction, model transformations and information loss, and estimating model accuracy of MIMO models. Use of MIMO models in controller design will be discussed. (Prerequisites: EEEE-707 and EEEE-709 or equivalent courses.) Lecture, Credits 3 (Spring)
EEE-768 Adaptive Signal Processing
An introduction to the fundamental concepts of adaptive systems; open and closed loop adaptive systems; adaptive linear combiner: performance function and minimization; decorrelation of error and input signal. Adaptation algorithms such as steepest descent, LMS and LMS/Newton algorithm. Noise and misadjustments. Applications will include system identification, deconvolution and equalization, adaptive arrays and multipath communication channels. (Prerequisites: EEEE-602 and EEEE-707 and EEEE-709 or equivalent courses.) Lecture, Credits 3 (Spring)

EEE-771 Optoelectronics
To provide an introduction to the operating principles of optoelectronic devices used in various current and future information processing and transmission systems. Emphasis in this course will be on the active optoelectronic devices used in optical fiber communication systems. Topics include optical resonators, quantum states of light, semiconductor optics, fundamental of lasers, light-emitting diodes, laser diodes, semiconductor photon detectors, optical modulators, quantum wells, and optical fiber communication systems. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Spring)

EEE-779 Digital Image Processing
This is an introductory course in digital image processing. The course begins with a study of two dimensional (2D) signal processing and transform methods with applications to images. Image sampling is discussed extensively followed by gray level description of images and methods of contrast manipulation including linear/nonlinear transformations, histogram equalization and specification. Image smoothing techniques are considered including spatial and frequency domain low pass filtering, AD-IHC methods of noise removal and median filtering. Following this, methods of image sharpening are studied including derivatives and high pass filtering. Edge and line detection algorithms are discussed using masks and Hough transforms. Finally, methods of image segmentation, restoration, compression and reconstruction are also discussed. Several extensive computer lab assignments are required. (Prerequisites: EEEE-678 equivalent course or graduate standing in EEEE-MS.) Lecture, Credits 3 (Fall)

EEE-780 Digital Video Processing
In this graduate level course the following topics will be covered: Representation of digital video - introduction and fundamentals; Time-varying image formation models including motion models and geometric image formation; Spatio-temporal sampling including sampling of analog and digital video; two dimensional rectangular and periodic Sampling; sampling of 3-D structures, and reconstruction from samples; Sampling structure conversion including sampling rate change and sampling lattice conversion; Two-dimensional motion estimation including optical flow based methods, block-based methods, Pel-recursive methods, Bayesian methods based on Gibbs Random Fields; Three-dimensional motion estimation and segmentation including methods using point correspondences, optical flow & direct methods, motion segmentation, and stereo and motion tracking. (Prerequisites: EEEE-779 or equivalent course. EEEE-779) Lecture, Credits 3 (Spring)

EEE-781 Image and Video Compression
This course studies the fundamental technologies used in image and video compression techniques and international standards such as JPEG and MPEG. At the highest level, all visual data compression techniques can be reduced to three fundamental building blocks: transformation or decomposition (examples are discrete cosine transform or DCT, wavelets, differential pulse code modulation or DPCM and motion compensation), quantization (strategies include scalar vs. vector quantization, uniform vs. nonuniform, Lloyd-Max and entropy-constrained quantization) and symbol modeling and encoding (the concept of Markov source and its entropy, context modeling, variable length coding techniques such as Huffman and arithmetic coding and Golomb-Rice coding). This course studies all of these fundamental concepts in great detail in addition to their practical applications in leading image and video coding standards. The study cases include a comprehensive review of the JPEG lossless compression standard (based on pixel prediction and Huffman coding), the JPEG lossy compression standard (based on DCT and Huffman coding), a detailed study of wavelet decomposition and a brief overview of the MPEG family of standards (employing motion compensation in addition to aforementioned techniques). (Prerequisites: EEEE-779 or equivalent course. EEEE-779) Lecture, Credits 3 (Spring)

EEE-784 Advanced Robotics
This course explores advance topics in mobile robots and manipulators. Mobile robot navigation, path planning, room mapping, autonomous navigation are the main mobile robot topics. In addition, dynamic analysis of manipulators, forces and trajectory planning of manipulators, and novel methods for inverse kinematics and control of manipulators will also be explored. The pre-requisite for this course is Principles of Robotics. However, students would have better understanding of the topics if they had Control Systems and Mechatronics courses as well. The course will be a project based course requiring exploration of a novel area in Robotics and writing an IEEE conference level paper. (Prerequisites: EEEE-585 or equivalent course or graduate standing in the EEEE-MS, EEEE-85MS program.) Lecture, Credits 3 (Spring)

EEE-787 MEMS Evaluation
This course focuses on evaluation of MEMS, microsystems and microelectromechanical motion devices utilizing MEMS testing and characterization. Evaluations are performed using performance evaluation matrices, comprehensive performance analysis and function. Applications of advanced software and hardware in MEMS evaluation will be covered. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture, Credits 3 (Spring)

EEE-789 Special Topics
Topics and subject areas that are not regularly offered are provided under this course. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. (Prerequisites: This course is restricted to graduate students in the EEEE-MS program.) Lecture, Credits 3 (Fall, Spring)

EEE-790 Thesis
Thesis An independent engineering project or research problem to demonstrate professional maturity. A formal written thesis and oral defense are required. The student must obtain the approval of an appropriate faculty member to guide the thesis before registering for the thesis. A thesis may be used to earn a maximum of 6 credits. Thesis, Credits 1 - 6 (Fall, Spring, Summer)

EEE-792 Graduate Paper
This course is used to fulfill the graduate paper requirement under the non-thesis option for the MS degree in electrical engineering. The student must obtain the approval of an appropriate faculty member to supervise the paper before registering for this course. Thesis, Credits 1 - 3 (Fall, Spring, Summer)

EEE-793 Error Detection and Error Correction
This course covers linear algebraic block codes, convolutional codes, turbo codes, and low-density parity-check codes. The fundamental structure of linear block code will be developed and applied to performance calculations. The structure of cyclic codes will be developed and applied to encoders and decoders. The major error correction methods, including error trapping, majority logic decoding and the BCH encoder and decoder algorithms will be developed. The Viterbi and sequential decoding algorithms will be studied. Questions of system performance, speed and complexity will be examined. Lecture, Credits 3 (Fall)

EEE-795 Graduate Seminar
The objective of this course is to introduce full time Electrical Engineering BS/MS and incoming graduate students to the graduate programs, campus resources to support research. Presentations from faculty, upper division MS/PhD students, staff, and off campus speakers will provide a basis for student selection of research topics, comprehensive literature review, and modeling effective conduct and presentation of research. All first year graduate students enrolled full time are required to successfully complete two semesters of this seminar. Seminar, Credits 0 (Fall, Spring)

EEE-797 Wireless Communication
The course will cover advanced topics in wireless communications for voice, data and multimedia. Topics covered are: 1) Channel modeling: Overview of current wireless systems, modeling wireless channels, path loss for different environments, log-normal shadowing, and frequency-sensitive multipath fading. LS estimation of channel parameters, and capacity limits of wireless communication channels. 2) Transmission over fading channels. 3) Techniques to improve the speed and performance of wireless links (adaptive modulation and diversity techniques such as maximum gain combining to compensate for flat-fading). 4) Techniques to combat frequency-selective fading (adaptive equalization, space time coding, multi-carrier modulation (OFDM), and spread spectrum). 5) Applications for these systems, including the evolution of cell phones and PDAs, sensor networks will be discussed. (Prerequisites: EEEE-593 or EEEE-693 and EEEE-602 or equivalent course.) Lecture, Credits 3 (Spring)

EEE-799 Independent Study
This course is used by students who plan to study a topic on an independent study basis. The student must obtain the permission of the appropriate faculty member before registering for the course. Independent Study, Credits 1 - 3 (Fall, Spring, Summer)

Industrial and Systems Engineering

ISEE-601 Systems Modeling and Optimization
An introductory course in operations research focusing on modeling and optimization techniques used in solving problems encountered in industrial and service systems. Topics include deterministic and stochastic modeling methodologies (e.g., linear and integer programming, Markov chains, and queuing models) in addition to decision analysis and optimization tools. These techniques will be applied to application areas such as production systems, supply chains, logistics, scheduling, healthcare, and service systems. (This course is restricted to students in the ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME or ENGMGT-ME program.) Lecture, Credits 3 (Fall)
Today represents a great challenge as well as a tremendous opportunity for most firms. (This is on supply chain management. There is a realization that no company can do any better than a consciously designed supply chain. Yet it is only recently that many firms have started focusing on this.)

Contemporary Production Systems
The focus of this course is Lean. Lean is about doing more with less - less human effort, less equipment, less time, less space. In other words, lean is about the application of industrial engineering principles and tools to the entire supply chain or value stream. The focus of this course will be learning and applying the principles and tools of lean such as value, value stream mapping, takt, flow, pull, kaizen, standard work, line design, and others, all in the context of continuous process improvement. By the end of this course, the student will possess the essential tools and skills to apply lean in their production system from either a line (supervisor or manager) or staff role. (This course is restricted to students in the ISEE BS/MS, ISEE BS/ME, ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME or ENG-MGT-ME programs or those with 5th year standing in ISEE-BS.) Lecture, Credits 3 (Fall)

Applied Statistical Quality Control
An applied approach to statistical quality control utilizing theoretical tools acquired in other math and statistics courses. Heavy emphasis on understanding and applying statistical analysis methods in real-world quality control situations in engineering. Topics include process capability analysis, acceptance sampling, hypothesis testing and control charts. Contemporary topics such as six-sigma are included within the context of the course. (This course is restricted to students in the ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME, ENG-MGT-ME or STAT-101/ACT program.) Lecture, Credits 3 (Fall)

Linear Regression Analysis
In any system where parameters of interest change, it may be of interest to examine the effects that some variables exert (or appear to exert) on others. "Regression analysis" actually describes a variety of data analysis techniques that can be used to describe the interrelationships among such variables. In this course we will examine in detail the use of one popular analytic technique: least squares linear regression. Cases illustrating the use of regression techniques in engineering applications will be developed and analyzed throughout the course. (This course is restricted to students in the ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME, ENG-MGT-ME or STAT-101/ACT program.) Lecture, Credits 3 (Fall)

Lean Six Sigma Fundamentals
This course presents the philosophy and methods that enable participants to develop quality strategies and drive process improvements. The fundamental elements of Lean Six Sigma are covered along with many problem solving and statistical tools that are valuable in driving process improvements in a broad range of business environments and industries. Successful completion of this course is accompanied by "yellow belt" certification for A's and B's only, and provides a solid foundation for those who also wish to pursue a "green belt." (Green belt certification requires completion of an approved project and exam, both of which are beyond the scope of this course.) (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring)

Linear Programming
Computational techniques for solving constrained optimization problems. Linear programming, the simplex method and variations, duality and sensitivity testing. (Prerequisites: ISEE-601 or ISEE-301 or equivalent course.) Lecture, Credits 3 (Spring)

Integer and Nonlinear Programming
An introduction to the mathematical foundations of integer programming and nonlinear optimization techniques. Study of algorithms and computer-aided solutions for applied optimization problems. (Prerequisites: ISEE-701 or equivalent course.) Lecture, Credits 3 (Fall)

Supply Chain Management
Supply chain management is unique in that it is one of the oldest business activities and yet it has been recently discovered as a potentially powerful source of competitive advantage. Supply chain system activities planning production levels, forecasting demand, managing inventory, warehousing, transportation, and locating facilities have been performed since the start of commercial activity. It is difficult to visualize any product that could reach a customer without a consciously designed supply chain. Yet it is only recently that many firms have started focusing on supply chain management. There is a realization that no company can do any better than its supply chain and logistics systems. This becomes even more important given that product life cycles are shrinking and competition is intense. Logistics and supply chain management today represents a great challenge as well as a tremendous opportunity for most firms. (This course is restricted to students in MILEAD-MS and PRODDEV-MS.) Lecture, Credits 3 (Fall)

Logistics Management
This course discusses several strategic, tactical, and operational concepts used in improving the distribution of goods and services by companies worldwide. The course emphasis is on understanding when and how these concepts are applied, as well as on using mathematical programming and optimization methods for their adequate implementation. (Prerequisites: ISEE-420 or ISEE-720 or equivalent course.) Lecture, Credits 3 (Fall)

Advanced Simulation
An advanced course in developing simulation models using good model building, verification and validation procedures. Emphasis will be on review and use of probability distributions, simulation output data analysis for making good decisions, comparison of alternative system configurations, use of designed experiments and the use of advanced simulation techniques. Real world case studies will be examined to convey understanding and teaching of the material. Students will be asked to build models, so simulation experience and working knowledge of a simulation language will be required. (Prerequisites: ISEE-510 or ISEE-610 or equivalent course.) Lecture, Credits 3 (Fall)

Production Control
This course will cover the role, the steps and the analysis methods to produce goods and services in support of the production and operations management functions. Topics include: forecasting, inventory policies and models, production systems and philosophies (e.g. JIT/Lean), job shop scheduling, aggregate production planning, and Material Requirement Planning (MRP). Students will understand the importance of production control and its relationship to other functions within the organization. Case studies and the design of actual production systems will be emphasized. (Prerequisites: ISEE-401 or ISEE-301 or ISEE-351 or ISEE-251 or ISEE-252 or ISEE-253 or ISEE-254 or ISEE-255 or equivalent courses.) Lecture, Credits 3 (Spring)

Production Systems Management
The focus of this course is Lean. Students who take this course should be interested in building on their basic knowledge of (lean) contemporary production systems and developing the breadth and depth of their understanding, with a focus on the managerial, quantitative, and systems aspects. It will also address value streams beyond manufacturing - specifically logistics. This course should enable the student to practice the application of lean concepts in the context of systems design at the enterprise level. (Prerequisites: ISEE-421 or ISEE-624 or equivalent course.) Lecture, Credits 3 (Spring)

Biomechanics
Course focuses on treatment of human body as a mechanical system to evaluate the effects of external forces on the musculoskeletal system. Course uses static models of equilibrium and computer software to analyze the effects of physical tasks on the body and to assess the likelihood of injury. Topics include musculoskeletal system, static modeling, and bio-instrumentation. (Prerequisites: MECE-200 or MECE-103 or equivalent course or graduate standing in ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME, ENG-MGT-ME, MECE-MS or MECE-ME program required.) Lecture, Credits 3 (Fall)

Advanced Topics in Human Factors and Ergonomics
Advanced topics are selected based on current ergonomic and human factors issues and interests of students. Course is taught using a seminar format. Students are required to select, read, and discuss scientific literature relevant to the fields of human factors and ergonomics. (Prerequisites: ISEE-330 or (ISEE-330 or ISEE-315) or equivalent course or graduate standing in ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME, ENG-MGT-ME program.) Lecture, Credits 3 (Spring)

Systems Safety Engineering
Acquaints students with practical aspects of safety engineering. Students acquire a working knowledge of legal and technical aspects of safety. Focuses on a systems approach to safety engineering. Topics include: Workers Compensation, OSHA, Consumer Product Safety Commission, NIOSH Guidelines and various hazard analysis and utilization techniques. Students also are exposed to various theories of accident causation, research methodology and ways of evaluating safety programs and related research. (This course is restricted to students in the ISEE BS/MS, ISEE BS/ME, ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME, ENG-MGT-ME, MECE-MS or MECE-ME program.) Lecture, Credits 3 (Spring)

Design for Manufacture and Assembly
Course reviews operating principles of prevalent processes such as casting, molding, and machining. Students will use this knowledge to select appropriate production processes for a given component. For each process covered, guidelines governing proper design for manufacturability practices will be discussed and applied. (Prerequisites: ISEE-140 or MECE-104 or equivalent course or graduate standing in ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME, ENG-MGT-ME, MECE-MS or MECE-ME program.) Lecture, Credits 3 (Fall)
ISEE-741 3D Printing
This course begins with an introduction to commercial rapid prototyping processes, the materials involved, and the physics behind how they work. The course then transitions to research topics involving novel processes, applications, and materials. Class activities include a mix of lecture, lab, and project work. (Prerequisites: ISEE-140 or MECE-104 or MECE-304 or MECE-305 or equivalent course or graduate standing in ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME, ENGMGT-MS, MECE-MS or MECE-ME program.) Lecture, Credits 3 (Spring)

ISEE-745 Manufacturing Systems
This course will provide an introduction to concepts and techniques in the design and analysis of production systems. A blend of traditional and modern approaches is brought into the classroom. At the end of the quarter, the student will be able to assess and analyze the performance of a given manufacturing system as well as to provide a framework for system redesign and improvement. Modern aspects such as lean manufacturing and setup time reduction are included in the context of the course. (This course is restricted to students in MFLDEV-MS and PRODDEV-MS.) Lecture, Credits 3 (Spring)

ISEE-750 Systems and Project Management
Systems and Project Management ensures progress toward objectives, proper deployment and conservation of human and financial resources, and achievement of cost and schedule targets. The focus of the course is on the utilization of a diverse set of project management methods and tools. Topics include strategic project management, project and organization learning, cost, schedule planning and control, structuring of performance measures and metrics, technical teams and project management, information technology support of teams, risk management, and process control. Course delivery consists of lectures, speakers, case studies, and experience sharing, and reinforces collaborative project-based learning and continuous improvement. (This course is restricted to students in the ISEE BS/MS, ISEE BS/ME, ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME, ENGMGT-MS, PRODDEV-MS or MFLDEV-MS programs or those with at least 4th year standing in ISEE-BS.) Lecture, Credits 3 (Fall)

ISEE-751 Decision and Risk Benefit Analysis
This course addresses decision making in the face of risk and uncertainty. Various methodologies will be introduced that are useful in describing and making decisions about risks, with particular emphasis on those associated with the design of products. Students will be exposed to issues related to balancing risks and benefits in situations involving human safety, product liability, environmental impact, and financial uncertainty. Presentations will be made of risk assessment studies, public decision processes, and methods for describing and making decisions about the societal risks associated with engineering projects. Topics include probabilistic risk assessment, cost-benefit analysis, reliability and hazard analysis, decision analysis, portfolio analysis, and project risk management. (This course is restricted to students in MFLDEV-MS and PRODDEV-MS.) Lecture, Credits 3 (Spring)

ISEE-752 Design Analysis
This course presents the primary concepts of decision analysis. Topics important to the practical assessment of probability and preference information needed to implement decision analysis are considered. Decision models represented by a sequence of interrelated decisions, stochastic processes and multiple criteria are also considered. (Prerequisites: QCAAS-252 or STAT-252 or MATH-252 or equivalent course or graduate student standing in the ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME or ENGMGT-MS program.) Lecture, Credits 3 (Fall)

ISEE-760 Design of Experiments
This course presents an in-depth study of the primary concepts of experimental design. Its applied approach uses theoretical tools acquired in other mathematics and statistics courses. Emphasis is placed on the role of replication and randomization in experimentation. Numerous designs and design strategies are reviewed and implications on data analysis are discussed. Topics include: consideration of type I and type II errors in experimentation, sample size determination, completely randomized designs, randomized complete block designs, blocking and confounding in experiments, Latin square and Gracco Latin square designs, general factorial designs, the 2k factorial design system, the 3k factorial design system, fractional factorial designs, Taguchi experimentation. (Prerequisites: QCAAS-252 or STAT-252 or MATH-252 or equivalent course or graduate student standing in the ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME or ENGMGT-MS program.) Lecture, Credits 3 (Spring)

ISEE-770 Design Project Leadership
This course focuses on preparing students to take on a leadership role in design project teams. Topics include product development processes, management of design project teams, developing a business case for design projects, understanding customer needs and translating them into engineering specifications, tools for developing design concepts, tools for assessing the feasibility of design concepts, conducting engineering tradeoffs and analysis to synthesize a preliminary design. Students use the concepts and tools discussed throughout the course in a team-based environment to develop project readiness packages for subsequent use by senior design teams. (Prerequisites: ISEE-350 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

ISEE-771 Engineering of Systems I
This course covers the principles of product, manufacturing process and supply chain development in an integrated fashion. It will examine the methodologies and tools to systematically define, develop and produce world-class products. Students will work on a project to put these methodologies and tools into practice. Major topics include: product planning and definition, characterization of user value, lean product development, product requirements and benchmarking, concept generation, design for “X” (manufacturing/assembly/service/environment, etc.), sustainable design, design for lean six sigma. (This course is restricted to students in the ISEE BS/MS, ISEE BS/ME, ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME, PRODDEV-MS, MSLEAD-MS or ENGMGT-MS programs or those with 5th year standing in ISEE-BS.) Lecture, Credits 3 (Fall, Spring)

ISEE-772 Engineering of Systems II
The engineering of a system focuses on the overall concept, performance, requirements and behavioral aspects of the system. This course builds on the concepts discussed in Engineering of Systems I. Topics include concept generation and innovation techniques, outsourced product development, requirements engineering and management, critical parameter management, robust design and latitude development, quality by design, advanced product development process management, and lean product development. Students will learn several systems analysis techniques and may include a team based project. (Prerequisites: ISEE-771 or equivalent course.) Lecture, Credits 3 (Spring)

ISEE-775 Advanced Systems Integration
Introductory course in concepts and techniques needed to specify, design, and implement integrated manufacturing systems. Upon completion of this course, one should have knowledge of the information flow in a manufacturing enterprise, understanding of basic concepts and issues in integrating various types of information systems, comprehension of sensors, transducers, and other techniques in capturing, analyzing, and displaying data at various levels within a manufacturing enterprise. Students will be expected to write programs to perform low-level control of electro-mechanical devices. In addition to lectures, the course will be augmented with lab exercises. (Prerequisites: ISEE-200 or graduate standing in the ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME or ENGMGT-MS program.) Lecture, Credits 3 (Fall)

ISEE-779 Special Topics
Topics and subject areas that are not regularly offered are provided under this course. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. Lecture, Credits 3 (Fall, Spring)
ISEE-790 Thesis
In conference with a faculty adviser, an independent engineering project or research problem is selected. The work may be of a theoretical and/or computational nature. A state-of-the-art literature search in the area is normally expected. A formal written thesis and an oral defense with a faculty thesis committee are required. Submission of bound copies of the thesis to the library and to the department and preparation of a written paper in a short format suitable for submission for publication in a refereed journal are also required. Approval of department head and faculty adviser needed to enroll. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 6 (Fall, Spring, Summer)

ISEE-793 Manufacturing Leadership Capstone
For the MS in Manufacturing Leadership program. The purpose of the project is for students to demonstrate integrative application of knowledge and skills that they have acquired during the program. A capstone project will be oriented to the solution of manufacturing, operations, or supply chain management problem or to technically related processes. Each project will define an actual problem and solve it, or select and develop a needed process. Each project must be approved in advance by the Capstone Coordinator. A suitable project will be multi-disciplinary or multi-functional in nature and will have significant impact on one or more competitive capabilities of the organization, e.g., quality, lead time, cost, flexibility, or service. Team-based projects are strongly recommended. (MEFLEAD-MS) Lecture, Credits 3 (Spring)

ISEE-794 Leadership Capstone
For students enrolled in the BS/ME dual degree program. Student must either: 1) serve as a team leader for the multidisciplinary senior design project, where they must apply leadership, project management, and system engineering skills to the solution of unstructured, open-end ed, multi-disciplinary real-world engineering problems, or 2) demonstrate leadership through the investigation of a discipline-related topic. (Enrollment in this course requires permission from the department offering the course.) Seminar, Credits 0 (Fall, Spring)

ISEE-795 Graduate Seminar I
The first in a two course sequence that introduces students to research methods in industrial engineering and presents the state of the art in industrial engineering research. The two-course sequence is designed to promote discussion and interaction on IE research topics and to present research methods such as conducting critical reviews of research literature, initiating background research on a thesis topic, and preparing a formal thesis proposal. (This course is restricted to students in the ISEE BS/MS, ISEE BS/ME, SUSTAIN BS/MS, SUSTAIN BS/ME, ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME or ENGMGT-ME program.) Seminar, Credits 0 (Fall)

ISEE-796 Graduate Seminar II
The second in a two course sequence that introduces students to research methods in industrial engineering and presents the state of the art in industrial engineering research. The two-course sequence is designed to promote discussion and interaction on IE research topics and to present research methods such as conducting critical reviews of research literature, initiating background research on a thesis topic, and preparing a formal thesis proposal. (This course is restricted to students in the ISEE BS/MS, ISEE BS/ME, SUSTAIN BS/MS, SUSTAIN BS/ME, ISEE-MS, ISEE-ME, SUSTAIN-MS, SUSTAIN-ME or ENGMGT-ME program.) Lecture, Credits 0 (Spring)

ISEE-799 Independent Study
This course is used by students who plan to study a topic on an independent study basis. The student must obtain the permission of the appropriate faculty member before registering for the course. Students registering for more than four credit hours must obtain the approval of both the department head and the adviser. (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1 - 3 (Fall, Spring, Summer)

Mechanical Engineering

MECE-606 Systems Modeling
This course is designed to introduce the student to advanced systems modeling techniques and response characterization. Mechanical, electrical, fluid, and mixed type systems will be considered. Energy-based modeling methods such as Lagrange's methods will be used extensively for developing systems models. System performance will be assessed through numerical solution using MATLAB/Simulink. Computer projects using Matlab/Simulink will be assigned and graded in this course. Linearization of nonlinear system models and verification methods are also discussed. (Prerequisite: MECE-320 or equivalent course or graduate standing in the MECE-ME or MECE-MS program.) Lecture, Credits 3 (Spring)

MECE-620 Introduction To Optimal Design
This course is an introduction to basic optimization techniques for engineering design synthesis. Topics covered include: techniques, the general problem statement, necessary conditions of optimization, numerical techniques for unconstrained optimization, constrained optimization through unconstrained optimization, and direct methods. Numerical solutions are obtained using MATLAB software. A design project is required. (Prerequisites: MECE-317 or graduate standing in the MECE-MS or MECE-ME program.) Lecture, Credits 3 (Spring)

MECE-623 Powertrain Systems and Design
This course will introduce the analysis and design of power transmission systems. Topics covered include spur, helical, bevel, and worm gears, gear trains, planetary gear systems, power transmission shafts, belt and chain drives, and systems such as electric and hydraulic power transmission. The transmission of power at the required speed and torque is the primary function of most power transmission systems, and is the focus of this course. Students will use this foundation to complete a case study project whereby they review and analyze how power is transmitted from the primary source to the remainder of the driveline by means such as manual transmissions, automatic transmissions, continuously variable transmissions, and direct drive systems. (Prerequisite: MECE-350 or graduate standing in MECE-ME or MECE-MS program.) Lecture, Credits 3 (Fall)

MECE-624 Vehicle Dynamics
Deals with the fundamentals of ground vehicle stability and control. The contribution of tire lateral force, stiffness, and aligning torque to vehicle stability is discussed. Bicycle and four-wheel vehicle models are analyzed for neutral, under and oversteer characteristics. The effects of suspension geometry, chassis stiffness and roll stiffness on stability and handling are analyzed. (Co-requisite: MECE-320 or equivalent course or graduate standing in the MECE-MS or MECE-ME program.) Lecture, Credits 3 (Spring)

MECE-625 Lab Applications in Mechatronics
This course provides a culminating experience for the mechatronics engineering certificate, relying upon the completed coursework and culminating in development of laboratory experiences related to mechatronics. Students enrolled in the course will design and prepare a novel lab experiment and complete lab experiments created by peers. (Prerequisite: MECE-451 or equivalent course.) Lab 1, Lecture 2, Credits 3

MECE-629 Renewable Energy Systems
This course provides an overview of renewable energy system design. Energy resource assessment, system components, and feasibility analysis will be covered. Possible topics to be covered include photovoltaics, wind turbines, solar thermal, hydropower, biomass, and geothermal. Students will be responsible for a final design project. (Prerequisites: MECE-310 and MECE-352 or graduate standing in the MECE-MS or MECE-ME program.) Lecture, Credits 3 (Fall)

MECE-638 Design of Machine Systems
This is an applied course in the selection of components and integration of those components into electro-pneumatic-mechanical devices and systems. Topics involve all aspects of machine design, including drive components and systems, motion generation and control, and electrical control hardware and strategy. (Prerequisites: MECE-205 and MECE-350 or equivalent courses or graduate standing in the MECE-MS or MECE-ME program.) Lecture, Credits 3 (Fall)

MECE-643 Classical Controls
This course introduces students to the study of linear control systems, their behavior and their design and use in augmenting engineering system performance. Topics include control system behavior characterization in time and frequency domains, stability, error and design. This is accomplished through classical feedback control methods that employ the use of Laplace transform, Bode diagrams, root locus, and Bode diagrams. An integrated laboratory will provide students with significant hands-on analysis and design-build-test experience. (Prerequisites: MECE-320 or equivalent course or graduate standing in the MECE-ME or MECE-MS program.) Lecture/Lab, Credits 3 (Fall, Spring)

MECE-644 Introduction To Composite Materials
This course is an introductory course to the fundamentals and applications of composite materials. Topics covered include constituents of composite materials, fabrication techniques, micromechanical analysis, macroscale analysis, and the use of composites in design. Some laboratory work is to be performed, and a design project is required. Lecture, Credits 3 (Fall)
MECE-687  Applied Biomaterials  This course is an introduction to the design of medical devices and issues that are unique to these devices. Course content includes some historical background, an overview of existing devices and trends, material selection, interfaces of medical devices with biological tissues, product testing, reliability, and regulations specific to the design and validation of medical devices. A substantial part of the course is a project, in which students will be required to work in teams to complete a preliminary design of a novel device, including appropriate analysis and documentation. Analysis methods learned from prior coursework in the students discipline will be applied to this component of the course. Lecture, Credits 3 (Spring)

MECE-658  Introduction to Engineering Vibrations  This course introduces students to research methods in mechanical engineering. A primary focus of the course is on conducting critical reviews of literature, preparing a formal thesis proposal, and initiating background research on a topic. At the conclusion of the course, the students are expected to submit a formal thesis proposal, literature review, and plan of study for the completion of the Master of Science degree. This course is specifically designed for students enrolled in the dual degree MS/BS program offered through the department. (MECE-MS, MECE-ME) Lecture, Credits 3 (Fall)

MECE-710  Research Methods  This course introduces students to research methods in mechanical engineering. A primary focus of the course is on conducting critical reviews of literature, preparing a formal thesis proposal, and initiating background research on a topic. At the conclusion of the course, the students are expected to submit a formal thesis proposal, literature review, and plan of study for the completion of the Master of Science degree. This course is specifically designed for students enrolled in the dual degree MS/BS program offered through the department. (MECE-MS, MECE-ME) Lecture, Credits 3 (Fall)

MECE-689  Grad Lower Level Special Topic  Topics and subject areas that are not regularly offered are provided under this course. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. Lecture, Credits 3 (Fall, Summer)

MECE-707  Engineering Analysis  This course trains students to utilize mathematical techniques from an engineering perspective, and provides essential background for success in graduate level studies. An intensive review of linear and nonlinear ordinary differential equations and Laplace transforms is provided. Laplace transform methods are extended to boundary-value problems and applications to control theory are discussed. Problem solving efficiency is stressed, and to this end, the utility of various available techniques are contrasted. The frequency response of ordinary differential equations is discussed extensively. Applications of linear algebra are examined, including the use of eigenvalue analysis in the solution of linear systems and in multivariate optimization. An introduction to Fourier analysis is also provided. (Prerequisites: (MATH-241 and MATH-326) or graduate student standing in the MECE-MS or MECE-ME programs.) Lecture, Credits 3 (Fall, Spring)

MECE-730  Design Project Leadership  This course focuses on preparing students to take on a leadership role in design project teams. Topics include product development processes, management of design project teams, developing a business case for design projects, understanding customer needs and translating them into engineering specifications, tools for developing design concepts, tools for assessing the feasibility of design concepts, conducting engineering tradeoffs and analysis to synthesize a preliminary design. Students use the concepts and tools discussed throughout the course in a team-based environment to develop project readiness packages for subsequent use by senior design teams. (This course is restricted to students in an MECE-BS/MS program or MECE-MS or MECE-ME.) Lecture, Credits 3 (Spring)

MECE-731  Computational Fluid Dynamics  This course covers the basics of introduction to Computational Fluid Dynamics (CFD) n fluid mechanics and heat transfer. CFD methods of flow modeling are introduced with emphasis of in-class use of CFD software for modeling and problem solution. Course work involves tutorials and design examples. This course also introduces the students to some of the commercial CFD codes being used for solving thermal-fluid problems. Students complete an individual CFD study project involving a written report and a presentation of the results. (Prerequisites: MECE-210 and MECE-317 or equivalent courses or graduate standing in the MECE-MS or MECE-ME.) Lecture, Credits 3 (Fall)

MECE-735  Sustainable Energy Management  This course, Sustainable Energy Management and the Built Environment, provides an overview of mechanical and associated control systems within buildings with an emphasis on sub-systems which possess the most visible energy signature in terms of energy usage, energy inefficiency, and societal/global impact. Fundamentals of system operation are explored as well as energy management techniques. Using domestic and international case studies which highlight energy management within the built environment, students will explore methods by which engineers have achieved solutions aligned with sustainability. (Prerequisites: MECE-310 and MECE-352 or graduate standing in the MECE-MS or MECE-ME program.) Lecture, Credits 3 (Fall)

MECE-738  Ideal Flows  This course covers the fundamental topics in the theory of aerodynamics and high speed flows. The course discusses modern aerodynamic applications in the areas of wing and airfoil design, wind tunnel testing and compressible flows. (Prerequisites: MECE-210 or equivalent course or graduate standing in the MECE-MS or MECE-ME program.) Lecture, Credits 3 (Spring)

MECE-739  Alternative Fuels and Energy Efficiency  This course provides an overview of the potential alternative fuels and energy efficiency technologies for powering current and future vehicles. Alternative fuel production technologies and utilization of fuels such as biodiesel, ethanol, and hydrogen will be covered. The primary technical and environmental issues associated with these alternative fuels will be discussed. Approaches to improving vehicle efficiency will also be explored. Students will be responsible for a final design or research project. (Prerequisites: MECE-352 or equivalent course or graduate standing in the MECE-MS or MECE-ME program.) Lecture, Credits 3 (Fall)

MECE-743  Digital Controls  This course builds on the fundamentals of continuous feedback control to introduce the student to computer (digital) regulation of systems in closed-loop. Discrete-time modeling and stability of signals and systems are discussed. Analog and digital control schemes are compared using s domain to z-domain conversion, and time-domain response characterization. Closed-loop system design objective specification and evaluation is conducted through numerical simulation and experimental observation. Various discrete-time controller designs are implemented and evaluated using Matlab/Simulink. (Prerequisites: MECE-643 or equivalent course.) Lecture, Credits 3 (Spring)

MECE-744  Nonlinear Controls  This course introduces the student to methods used to design advanced nonlinear control systems. Topics of this course include: Phase-State Plane Analysis, Existence of Limit Cycles, Lyapunov Stability (Direct and Indirect methods), nonlinear control design using Feedback Linearization, the Sliding Mode Control method, Numerical Optimization of PID laws, and Adaptive Control strategies. Students are expected to complete computer projects using Matlab/Simulink. (Prerequisites: MECE-643 or equivalent course.) Lecture, Credits 3 (Spring)

MECE-746  Engineering Properties of Materials  This course presents the principles behind various properties of materials from an atomic and molecular perspective. Topics from physical chemistry and solid state physics and engineering are covered. Topics include: crystallography, thermodynamics of condensed phases, and thermal, elastic, electrical and magnetic properties. This course is oriented for advanced undergraduate and graduate students with previous knowledge of materials science. (Prerequisites: MECE-305 or equivalent course or graduate standing in the MECE-MS or MECE-ME program.) Lecture, Credits 3 (Fall)

MECE-751  Convective Phenomena  This course introduces the student to the flow of real incompressible fluids. The differential approach is used to develop and solve the equations governing the phenomena of mass, momentum, and heat transfer. The material in the course provides the necessary background for a study of computational fluid dynamics. (Prerequisites: MECE-210 or equivalent courses or graduate standing in the MECE-MS or MECE-ME program.) Lecture, Credits 3 (Spring)

MECE-752  Tribology Fundamentals  This course provides an overview of the role of fluid-film lubrication in mechanical design, with strong emphasis on applications. Various forms of the Reynolds equation governing the behavior of lubricant films for planar, cylindrical, and spherical geometry are derived. Mobility and impedance concepts as solution methods of the Reynolds equation are introduced for the performance assessment of lubricated journal bearings under static and dynamic loading. Short, long, and finite bearing assumptions are discussed. Finite element methods for the analysis of fluid-film bearings of arbitrary geometry will be introduced. (Prerequisites: MECE-210 and MECE-371 and MECE-350 or equivalent courses or graduate standing in the MECE-MS or MECE-ME program.) Lecture, Credits 3 (Spring)
Graduate Course Descriptions

Kate Gleason College of Engineering

Microelectronic Engineering

MCEE-601 Microelectronic Fabrication
This course introduces the beginning graduate student to the fabrication of solid-state devices and integrated circuits. The course presents an introduction to basic electronic components and devices, layout, unit processes common to all IC technologies such as substrate preparation, oxidation, diffusion and ion implantation. The course will focus on basic silicon processing. The students will be introduced to process modeling using a simulation tool such as SUPREM. The lab consists of conducting a basic metal gate PMOS process in the RIT clean room facility to fabricate and test a PMOS integrated circuit test chip. Laboratory work also provides an introduction to basic IC fabrication processes and safety. (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) Lab, Lecture, Credits 3 (Fall)

MCEE-602 Semiconductor Process Integration
This is an advanced level course in Integrated Circuit Devices and process technology. A detailed study of processing modules in modern semiconductor fabrication sequences will be done through simulation. Device engineering challenges such as shallow-junction formation, fin FETs, ultra-thin gate dielectrics, and replacement metal gates are covered. Particular emphasis will be placed on non-equilibrium effects. Silvaco Athena and Atlas will be used extensively for process simulation. (Prerequisites: MCEE-601 or equivalent course.) Lab, Lecture, Credits 3 (Fall, Spring)

MCEE-603 Thin Films
This course focuses on the deposition and etching of thin films of conductive and insulating materials for IC fabrication. A thorough overview of vacuum technology is presented to familiarize the student with the challenges of creating and operating in a controlled environment. Physical and Chemical Vapor Deposition (PVD & CVD) are discussed as methods of film deposition. Plasma etching and Chemical Mechanical Planarization (CMP) are studied as methods for selective removal of materials. Applications of these fundamental thin film processes to IC manufacturing are presented. (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) Lab, Lecture, Credits 3 (Fall, Spring)

MCEE-605 Lithography Materials and Processes
Microlithography Materials and Processes covers the chemical aspects of microlithography and resist processes. Fundamentals of polymer technology will be addressed and the chemistry of various resist platforms including novolac, styrene, and acrylate systems will be covered. Double patterning materials will also be studied. Topics include the principles of photoresist materials, including polymer synthesis, photochemistry, processing technologies and methods of process optimization. Also advanced lithographic techniques and materials, including multi-layer techniques for BARC, double patterning, TARC, and next generation materials and processes are applied to optical lithography. (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) Lab, Lecture, Credits 3 (Fall, Spring)

MCEE-615 Nanolithography Systems
An advanced course covering the physical aspects of micro- and nano-lithography. Image formation in projection and proximity systems are studied. Makes use of optical concepts as applied to lithographic systems. Fresnel diffraction, Fraunhofer diffraction, and Fourier optics are utilized to understand diffraction-limited imaging processes and optimization. Topics include illumination, lens parameters, image assessment, resolution, phase-shift masking, and resist interactions as well as non-optical systems such as EUV, maskless, e-beam, and nanoimprint. Lithographic systems are designed and optimized through use of modeling and simulation packages. (Prerequisites: MCEE-605 or equivalent course.) Lab, Lecture, Credits 3 (Fall, Spring)

MCEE-620 Photovoltaic Science and Engineering
This course focuses on the principle and engineering fundamentals of photovoltaic (PV) energy conversion. The course covers modern silicon PV devices, including the basic physics, ideal and non-ideal models, device parameters and design, and device fabrication. The course discusses crystalline, multi-crystalline, amorphous thin-film solar cells and their manufacturing. Students will become familiar with basic semiconductor processes and how they are employed in solar cells manufacturing. The course further introduces third generation advanced photovoltaic concepts including compound semiconductors, spectral conversion, and organic and polymeric devices. PV applications, environmental, sustainability and economic issues will also be discussed. Evaluations include assignments and exams, a research/report and on a current PV topic. (This course requires permission of the Instructor to enroll.) Lab, Lecture, Credits 3 (Spring)
MCEE-704 Physical Modeling of Semiconductor Devices
A senior or graduate level course on the application of simulation tools for physical design and verification of the operation of semiconductor devices. The goal of the course is to provide a more in-depth understanding of device physics through the use of simulation tools. Technology CAD tools include Silvaco (Athena/Atlas) for device simulation. The lecture will explore the various models that are used for device simulation, emphasizing the importance of complex interactions and 2-D effects as devices are scaled deep-submicron. Laboratory work involves the simulation of various device structures. Investigations will explore how changes in the device structure can influence device operation. (This course requires permission of the Instructor to enroll.) Lab, Lecture, Credits 3 (Fall)

MCEE-706 SiGe and SOI Devices and Technologies
This course introduces students to the fundamentals of III-V, SiGe and Silicon on Insulator (SOI) devices and fabrication technologies. The course will first discuss the band structure of the SiGe material system, and how its properties of band structure and enhanced mobility may be utilized to improve traditional Si devices. Basic heterojunction theory is introduced to students. Some specific applications that are introduced include heterojunction bipolar transistors (HBTs), SiGe-channel MOS devices, high-electron mobility transistors (HEMTs) and tunnel FETs. Fabrication technologies for realizing SOI structures that include SIMOX and SMART CUT technologies are described. The physics of transistors built on SOI substrates will be discussed. At the completion of the course, students will write a review paper on a topic related to the course. (This course requires permission of the Instructor to enroll.) Lecture, Credits 3 (Fall)

MCEE-713 Quantum and Solid-State Physics for Nanostructures
This course describes the key elements of quantum mechanics and solid state physics that are necessary in understanding the modern semiconductor devices. Quantum mechanical topics include solution of Schrodinger equation solution for potential wells and barriers, subsequently applied to tunneling and carrier confinement. Solid state topics include electronic structure of atoms, crystal structures, direct and reciprocal lattices. Detailed discussion is devoted to energy band theory, effective mass theory, energy-momentum relations in direct and indirect band gap semiconductors, intrinsic and extrinsic semiconductors, statistical physics applied to carriers in semiconductors, scattering and generation and recombination processes. (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) Lecture, Credits 3 (Fall)

MCEE-714 Memory Systems
This course targets the overlapping areas of device physics, VLSI Design, advanced processes, electrical characterization and circuit architecture as it applies to modern memory systems. While there are no specific set of pre-requisite courses, students should be willing to work on problems involving the previously mentioned topics. Course work will trace the design, development, fabrication, packaging and testing of SRAM, DRAM and Flash Memory, and then branch off into MRAM, FRAM and PRAM technology. The course wraps up with an exploration of future memory system candidates such as quantum, molecular and optical memory systems. The course will write a term paper on an aspect of memory systems of particular interest to them (proposed topic must still be approved by the instructor). (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) Lecture, Credits 3 (Fall)

MCEE-730 Metrology for Failure Analysis and Yield of ICs
Successful IC manufacturing must detect defects (the non-idealities) that occur in a process, eliminate those defects that preclude functional devices (yield enhancement), and functionality for up to ten years of use in the field (reliability). Course surveys current CMOS manufacturing to compile a list of critical parameters and steps to monitor during manufacturing. This survey is followed with an in-depth look at the theory and instrumentation of the tools utilized to monitor these parameters. Tool set includes optical instrumentation, electron microscopy, surface analysis techniques, and electrical measurements. Case studies from industry and prior students are reviewed. Students are required to perform a project either exploring a technique not covered in class, or to apply their course knowledge to a practical problem. (Prerequisites: MCEE-201 or MCEE-360 or graduate student standing in the MCEE-MS program.) Lecture, Credits 3 (Fall)

MCEE-777 Master of Engineering Internship
This course number is used to fulfill the internship requirement for the master of engineering degree program. The student must obtain the approval of the department head before registering for this course. (Enrollment in this course requires permission from the department offering the course.) INT, Credits 1 - 4 (Fall, Spring, Summer)

MCEE-779 Special Topics
This is a variable credit, variable special topics course that can be in the form of a course that is not offered on a regular basis. (This course requires permission of the Instructor to enroll.) Lecture, Credits 1 - 3 (Fall, Spring, Summer)

MCSE-713 Lasers
This course introduces nonlinear concepts applied to the field of optics. Students learn how materials respond to high intensity electric fields and how the materials response: enables the generation of other frequencies, can focus light to the point of breakdown or create waves that do not disperse in time or space solitons, and how atoms can be cooled to absolute zero using a laser. Students will be exposed to many applications of nonlinear concepts and to some current research subjects, especially at the nanoscale. Students will also observe several nonlinear-optical experiments in a state-of-the-art photonics laboratory. (Prerequisites: EE31-374 or equivalent course or graduate student standing in the MCSE-PHD program.) Lecture, Credits 3 (Spring)

MCSE-714 Nonlinear Optics
This course introduces nonlinear concepts applied to the field of optics. Students learn how materials respond to high intensity electric fields and how the materials response: enables the generation of other frequencies, can focus light to the point of breakdown or create waves that do not disperse in time or space solitons, and how atoms can be cooled to absolute zero using a laser. Students will be exposed to many applications of nonlinear concepts and to some current research subjects, especially at the nanoscale. Students will also observe several nonlinear-optical experiments in a state-of-the-art photonics laboratory. (Prerequisites: EE31-374 or equivalent course or graduate student standing in the MCSE-PHD program.) Lecture, Credits 3 (Spring)
MCSE-731 Integrated Optical Devices and Systems
This course discusses basic goals, principles and techniques of integrated optical devices and systems, and explains how the various optoelectronic devices of an integrated optical system operate and how they are integrated into a system. Emphasis in this course will be on planar passive optical devices. Topics include optical waveguides, optical couplers, micro-optical resonators, surface plasmons, photonic crystals, modulators, design tools and fabrication techniques, and the applications of optical integrated circuits. Some of the current state-of-the-art devices and systems will be investigated by reference to journal articles. Lecture, Credits 3 (Fall)

MCSE-771 Optoelectronics
To provide an introduction to the operating principles of optoelectronic devices used in various current and future information processing and transmission systems. Emphasis in this course will be on the active optoelectronic devices used in optical fiber communication systems. Topics include pulse propagation in dispersive media, polarization devices, optical fiber, quantum states of light, fundamental of lasers, semiconductor optics, light-emitting diodes, laser diodes, semiconductor photon detectors, optical modulators, quantum wells, and optical fiber communication systems. (Prerequisite: This class is restricted to degree-seeking graduate students, 4th or 5th year status or those with permission from instructor.) Lecture, Credits 3 (Spring)

MCSE-799 Independent Study
This course allows graduate students an opportunity to independently investigate, under faculty supervision, topics related to microsystems engineering. Proposals for independent study activities and assessment are subject to approval by both the supervising faculty member and the department head. Independent Study, Credits 1 - 3 (Fall, Spring, Summer)

MCSE-877 Internship
Internship is designed to enhance the educational experience of PhD students through full-time employment. (Enrollment in this course requires permission from the department offering the course.) INT, Credits 0 (Spring)

MCSE-889 Special Topics
Topics and subject areas that are not regularly offered are provided under this course. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. (This course is restricted to students in the MCSE-PHD program or those with permission of instructor.) Lab, Lecture, Credits 3 (Fall, Spring)

MCSE-890 MCSE-Dissertation
Research in an appropriate topic as arranged by doctoral candidate and dissertation adviser in fulfillment of the dissertation requirement. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 27 (Fall, Spring, Summer)

Center for Quality and Applied Statistics
CQAS-683 Lean Six Sigma Project
Students in this course will work on a process improvement opportunity at an organization utilizing the DMAIC (Define, Measure, Analyze, Improve, and Control) approach to problem solving as well as the Lean Six Sigma tools. This course does not count as credit toward the CQAS MS degree. (Prerequisites: CQAS-682/ISEE-682 or equivalent course. Co-requisites: CQAS-621 or STAT-621 and CQAS-670 or STAT-670 or equivalent course.) Independent Study, Credits 3 (Fall, Spring, Summer)
## College of Health Sciences and Technology

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### HLTH-700: Research Methods
This is an introductory graduate-level survey course on research design/methods and analysis. The course provides a broad overview of the process and practices of social research in service-related contexts. Content includes principles and techniques of research design, sampling, data collection, and analysis including the nature of evidence, types of research, defining research questions, sampling techniques, data collection, data analysis, issues concerning human subjects and research ethics, and challenges associated with conducting research in real-world contexts. The analysis component of the course provides an understanding of statistical methodology used to collect and interpret data found in research as well as how to read and interpret data collection instruments. Lecture 3, Credits 3 (Fall, Spring)

### HLTH-702: Graduate Writing Strategies
Taught in conjunction with Research Methods students will become articulate in a variety of business and research communication methodologies. These methods will include writing a research proposal, a white paper, critique professional journal articles and prepare a grant proposal. A search of the literature for a defined research proposal will include an annotated bibliography to support the references used in the research proposal. Lecture 3, Credits 3 (Fall, Spring)

### HLTH-710: Health Governance and Economics
This course will review how health care law is created and promulgated from policy to regulations. Examination of specific laws that govern all health care in the USA will be reviewed as well as discussion of regulatory dynamics, the legislative process and regulatory trends in the United States. Emphasis will be placed on strategy development to respond to regulations including advocacy as a response to regulation interpretation and enforcement. Health economics overview will include an explanation of how health care economics are unique in the world of economics and who the major stakeholders are within health care economics including their motivation and reward systems. Given this knowledge strategies will be developed to deal with real and hypothetical challenges facing health care today from a legal and economic perspective. Lecture 3, Credits 3 (Spring)

### HLTH-712: Health Care Delivery
The health care industry is diverse and complex. This course is designed to provide a context for understanding the various elements of the US health care delivery system. The system is studied by reviewing the systems’ history and roots, current and future state. Students will study the unique personal service orientation of health care and the sub-systems that support care delivery. The course will cover: services and modes of care delivery; roles, responsibilities and relationships of providers, payers, patients, support personnel and policymakers; reimbursement and insurance systems; health care outcomes; health care reform and government policies. Students will view the health care delivery system from a critical perspective and develop solutions to the access, quality, and cost issues. Lecture 3, Credits 3 (Fall, Spring)

### HLTH-715: Reinventing Health Care
This course discusses reinventing health care in our country. Specifically the course will review the current status of American health care including research into population demographics and health and the concept of wellness and prevention. Following this a review of international health care models will occur to consider best practice as alternative care models for consideration for the US. Third the students will develop, for their area of interest and expertise a strategy for incremental or radical innovation in how we provide health care to our constituents. Lecture 3, Credits 3 (Fall, Spring)

### HLTH-717: Bioethics
This course will provide students with an ethical framework consisting of knowledge of the principle theories and moral philosophers and their methods to approach decision making. Ethics will be further explored giving consideration of cultural norms and how this influences societal ethical decision making; a review of the ethics of the professions of health care; information about gaining access to the organizations ethical principles and an understanding of personal ethics. Using these as a foundation personal and professional ethics will be explored, developed and a decision making rationale developed through a sequence of exercises requiring ethical decision making related to finance, human resources, clinical issues and personal morality. Lecture 3, Credits 3 (Spring, Summer)

### HLTH-723: Human Resources in Health Care
This course focuses on the changing competitive health care environment that has made human capital an organization’s key asset, with HR largely responsible for cultivating it. Specifically, students will learn the impact that human capital has on the HR division and function of health care organizations. The focus will be on how the “New HR” has become more strategic and fundamental to a health care organization’s success and the need to meet the demands of highly skilled, educated and credentialed health care professionals. Lecture 3, Credits 3 (Spring)

### HLTH-725: Marketing within Health Care
The ability to differentiate a health care facility within the market place provides a challenge to leadership. The government is pursing publication of quality results as the venue to differentiate quality providers for consumers. Health care facilities compete with each other yet lack the ability to focus on what differentiates their products and services from competitors including the mandated data reporting requirements. Lecture 3, Credits 3 (Summer)

### HLTH-730: Finance for Health Care Professionals
This is an overview course that will provide an in-depth investigation of the financial workings in the health care industry. The course will be presented through the investigation of the operations of various health care settings — hospitals, physicians practices, long term care facilities and home health care providers. The course covers all the essential functions in health care internal financial operations that would be experienced throughout the industry, except for the insurance companies. There are several examples involving physicians practices, inpatient hospitals, clinics, nursing homes, etc. During the course the participants will carefully evaluate what the finance department is expected to accomplish. They will better understand the role of the clinical operations managers in the financial health of an organization. The course is designed to provide an approach that includes some terminology used in accounting, but more so those terms associated with finance. Lecture 3, Credits 3 (Fall)

### HLTH-732: Health Insurance and Reimbursement
This course provides an in-depth review of the characteristics of successful health insurance plans with emphasis on cost containment and premium control techniques. Emphasis will be placed on learning various cost containment and quality improvement tools of an effective delivery system and how to apply those tools to different delivery structures. The relationship between shared risk and behavior change is explored as well as basic concepts of health insurance underwriting and the essentials of a successful provider payer partnership. Lecture 3, Credits 3 (Fall)

### HLTH-735: Management of Risk in Health Care
This course identifies the risk inherent within health care institutions, organizations, agencies and for individual providers. The management of risk is explored as part of a strategic response of an organization or individual within health care. Specifically the risk inherent within health care organizations; in communications and sharing of data; in the embracing of new technologies and drug treatment therapies; and the expectations of corporate compliance will be discussed. The role of quality assurance will be reviewed as a strategy to control risk. This is a required course in the Health Systems Administration program and assignments/applications are focused on healthcare issues. Lecture 3, Credits 3 (Spring)

### HLTH-736: Health Care Operations Management
The health care industry is large and growing. Faced with raising costs and quality issues, health care organizations are under unprecedented pressure to improve efficiency and quality. Consequently, there is a significant opportunity for health care organizations to better manage their operations. The purpose of this course is to provide students the opportunity to analyze health care organizations using both qualitative and quantitative principles of operations management. Students will learn to apply operations theories via case studies and issue analysis of their active work environments. This course is offered online. (Prerequisite: MTSC-211 or STAT-145 or equivalent course.) Lecture 3, Credits 3 (Spring)
**HLTH-737 Lean Sigma in Health Care**

This course teaches the principles Lean-Sigma & the application of its process improvement methodologies & tools in a health care environment. The curriculum examines the current challenges encountered in the healthcare industry and how the application of Lean-Sigma techniques can improve overall performance. A specific focus of the course is to learn the methodology used to obtain desired results of streamlining operations and enhancing administrative effectiveness in the clinical, administrative, and service segments of health care. **Lecture 3, Credits 3 (Summer)**

**HLTH-740 Health Care Leadership**

Highly trained clinical and administrative professionals drive the nature of work in health care. The purpose of this course is to provide students the opportunity to study leadership theory as it is applied in health care organizations. Leadership theories and applications geared toward professionals working in health service organizations will be emphasized. Students will learn to apply leadership theories via case studies and issue analysis of their active work environments. **Lecture 3, Credits 3 (Fall)**

**HLTH-750 Ethics in Human Subjects Research**

A comprehensive course in clinical research ethics. The course will present the history of ethical issues in research involving human subjects and the resulting development of regulatory requirements globally. Critical processes such as informed consent and institutional review boards will be reviewed extensively. Current issues such as conflict of interest and research involving genetic material will also be discussed and understanding the role of good science as good ethics will be included. **Lecture 3, Credits 3 (Spring)**

**HLTH-753 Clinical Trial Design**

This course is designed to provide graduate and upper-level undergraduate students with the basic principles behind the design of clinical research trials to effectively test medical hypotheses. The critical components of a well-designed clinical research protocol will be explored. Students will be introduced to the different types of clinical trials used in the industrial, government, and academic sectors for pharmaceutical, medical device, or biologic interventions. **Lecture 3, Credits 3 (Fall)**

**HLTH-754 Regulations and Clinical Practices**

This course is designed to provide the student with knowledge of the regulatory framework that governs clinical research activities. The principles that govern Good Clinical Practice and the responsibilities of the administrators involved in a clinical research study will be discussed. The history of the regulations and significant milestones in U.S. Food and Drug Law will also be presented. **Lecture 3, Credits 3 (Spring)**

**HLTH-755 Product Development Pharmaceutical, Device and Biologics Industries**

This course is designed as an overview of the product development process. It will describe activities used to bring different types of products from concept through testing to product approval. Domestic and International regulatory requirements for product approval will be discussed. Overall product development will be outlined with an emphasis on clinical research activities toward market approval. Students will learn the activities and requirements to get products through clinical research to FDA approval. **Lecture 3, Credits 3 (Fall)**

**HLTH-760 Health Care Informatics**

This course is intended to explore current challenges in the health care system, and how the ability to understand and apply health data can improve the quality and cost of health care services. The course will include a review of current and future data collection, storage and exchange practices; and utilize applied case studies allowing students to demonstrate their ability to use health care information technology systems and data analytics to improve patient and provider outcomes. **Lecture 3, Credits 3 (Fall)**

**HLTH-788 Thesis Planning**

Students will rigorously develop their thesis research ideas, conduct literature reviews, identify and plan methodologies, prepare schedules, and gain a clear understanding of the expectations of the faculty and the discipline. Each student will be required to prepare a committee approved thesis research proposal and may begin work on their thesis. (Enrollment in this course requires permission from the department offering the course.) **Lecture 3, Credits 3 (Fall, Spring)**

**HLTH-789 Selected Topics**

Selected topics is an innovative course not reflected in the accepted curriculum. Once the outline is submitted titles will appear in the course listing for the semester. The course may be taken more than once as topics change. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

**HLTH-790 Research Thesis**

A thesis is based on experimental evidence obtained by the candidate in an appropriate topic demonstrating the extension of theory into practice. A written proposal which is defended and authorized by the faculty advisor/committee followed by a formal written thesis and oral presentation of findings are required. Typically the candidate will have completed Research methods, Data analysis and Graduate writing strategies prior to enrolling in this course and will start the thesis process as soon as they have completed these courses to allow them to finish the thesis when they have finished their coursework. The candidate must obtain the approval of their Graduate advisor who will guide the thesis before registering for this course. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 2 - 6 (Fall, Spring, Summer)**

**HLTH-794 Integrative Problem Solving**

Students will demonstrate synthesis and integration of the theories and foundation principles of their discipline. This will be achieved through application of core knowledge in a series of progressive problems. **Lecture 3, Credits 3 (Fall, Summer)**

**HLTH-795 Comprehensive Examination**

A written comprehensive exam is one of the non-thesis methodologies for completion of the MS degree. Students will demonstrate a fundamental knowledge of the theories and foundation principles. This course will include a review of the main concepts of each of the core subjects and at the conclusion of the course the student will take a written examination and must receive a passing grade of at least 80% to be successful. Students will have one additional opportunity to pass this examination if their initial attempt results in a failing grade. (Enrollment in this course requires permission from the department offering the course.) **CMP 3, Credits 0 (Fall, Summer)**

**HLTH-797 Capstone Project**

The purpose of this course is to provide students the opportunity to conduct research, develop a plan and evaluation components and submit the project as a demonstration of final proficiency in the program. The topic selected by the student will be guided by the faculty teaching the class and it will require the student to coalesce and incorporate into the final project the culmination of all their course work in the program to date. (This class is restricted to students who have completed HLTH-720 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

**HLTH-799 Independent Study**

Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty advisor, will propose a course of study. Independent Study students must obtain permission of an instructor and complete the CHST Graduate Independent Study Form to enroll. **Independent Study 1, Credits 1 - 4 (Fall, Spring, Summer)**

### Medical Illustration

**ILLM-601 Human Gross Anatomy**

This course provides an in-depth study of the structure of the human body. Emphasis is on understanding the relationships between anatomical structures as well as their form, texture, and color. Dissection of a human cadaver is supplemented with lectures on the structure and function of the major organ systems. **ILLM-MFA Lab 9, Lecture 3, Credits 6 (Fall)**

**ILLM-602 Anatomic Studies**

Through independent research and acquired understanding of human gross anatomy, students create illustrations designed to support medical or graduate level instruction of Human Gross Anatomy. Course requires students to cognitively illustrate their subjects, rather than creating literal interpretations of their observations. Work is intended for full color print media. **ILLM-MFA Studio 5, Credits 3 (Fall)**

**ILLM-603 3D Modeling of Biomedical Forms**

This course introduces strategies to create polygonal models of biomedical subjects. Students will use contemporary research to accurately define structure and suggest function. Instruction will also focus on lighting and "shading" systems that emphasize form and are consistent with tissue characteristics. **ILLM-MFA Lecture 1, Studio 4, Credits 3 (Fall)**

**ILLM-607 Computer Applications in Medical Illustration**

Students will learn to use industry-standard raster and vector illustration software to create images based on independent research of medical topics. Students will also use page layout applications to combine digital images with text and other graphic elements. Coursework emphasizes creation of illustrations to support medical education and publishing. **ILLM-MFA Lecture 2, Studio 3, Credits 3 (Spring)**
Scientific Visualization
Emerging technologies enable scientists to visualize structures that are otherwise invisible to the naked eye. For example, molecular visualization software allows us to construct highly accurate molecular models from x-ray crystallography and other structural data. Cryo-EM and confocal microscopy are revealing the previously unknown structure of cellular organelles. Medical imaging systems allow us to reconstruct the human body in three dimensions from actual patient data (CT scans, MRI, etc.). This course explores the use of these technologies to provide references for traditional artwork and to export models for digital rendering and animation. (Prerequisites: ILLM-601 or equivalent course.) Lecture/Lab 6, Credits 3 (Spring)

Surgical Illustration
Students observe and sketch live surgical procedures at a local hospital. After further background research, students translate their sketches into finished illustrations that are used in medical training, patient education, and litigation. Demonstrations of sketching and rendering techniques are supplemented with lectures on general surgical principles and common procedures. (Prerequisites: ILLM-601 and ILLM-607 or equivalent courses.) Lab 3, Lecture 3, Credits 3 (Fall)

Interactive Media I
This course is an introduction to two dimensional computer illustration, animation, and interactive media as they apply to contemporary methods of instruction in medicine and allied health. Students will research a current topic in health care and develop interactive lessons that match the instructional objectives of their topic. Students will organize these lessons as a web site. (Prerequisites: ILLM-607 or equivalent course.) Lecture/Lab 6, Credits 3 (Fall)

Interactive Media II
This course continues the development of student web sites designed for allied health instruction. Advanced topics in two dimensional computer illustration, animation, and interactive media will be presented. Students will research current topics in health care and continue the development of the interactive lesson begun in the previous class. (Prerequisites: ILLM-615 or equivalent course.) Studio 6, Credits 3 (Spring)

Portfolio and Business Practices
This course helps prepare students to enter the workforce in full-time positions or as freelance illustrators. Students create a traditional portfolio, personal identity package, and marketing materials. The course also introduces important business concepts such as copyright, licensing, pricing, contracts, taxation, and formation of a proper business. (Prerequisites: ILLM-612 or equivalent course.) Lab 3, Lecture 2, Credits 3 (Spring)

Eye Ear and Nose Prosthetics
This course provides an introduction to the field of anaplastology, a branch of medicine dealing with the prosthetic replacement or correction of an absent, disfigured, or malformed anatomic structure, usually on the face or limbs. Focusing on maxillofacial prosthetics and ocular prosthetics (artificial eyes), students learn the basic technical skills needed for an internship or apprenticeship in this field. **Fee: There is a $45 fee for this course** (Prerequisites: This course is restricted to ILLM-MFA students who have successfully completed ILLM-601 or equivalent course.) Lecture 2, Studio 3, Credits 3 (Spring)

Independent Study
Medical Illustration Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty advisor will propose a course of study. Medical Illustration Independent Study students must obtain permission of an instructor and complete the Independent Study Permission Form to enroll. Independent Study, Credits 1 - 6 (Fall, Spring, Summer)

Thesis
Students conduct background research and create a body of artwork on a contemporary medical topic. The artwork is exhibited during one of several graduate thesis shows or during a screening of digital animation and interactive works. The thesis culminates with the production of a written thesis paper that documents the process of creating the work. (ILLM-MFA) Thesis, Credits 1 - 14 (Fall, Spring)

The Continuation of Thesis course provides students additional semester(s) to complete their thesis research, project, and thesis document Thesis, Credits 0 (Fall, Spring, Summer)
PHYA-754 Surgery
This mandatory rotation in the field of surgery provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or PHYAST-BS or those students with graduate standing in PHYA-MS.) CLN 15, Credits 4 (Fall, Spring, Summer)

PHYA-755 Orthopedics
This mandatory rotation in the field of orthopedic medicine provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or PHYAST-BS or those students with graduate standing in PHYA-MS.) CLN 15, Credits 4 (Fall, Spring, Summer)

PHYA-756 Geriatrics
This mandatory rotation in the field of geriatric medicine provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or PHYAST-BS or those students with graduate standing in PHYA-MS.) CLN 15, Credits 4 (Fall, Spring, Summer)

PHYA-757 Psychiatry
This mandatory rotation in the field of psychiatric medicine provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (Matriculation into the fifth year of the PA Program) (This class is restricted to students in PHYA-BS with at least 4th year standing or PHYAST-BS or those students with graduate standing in PHYA-MS.) CLN 15, Credits 4 (Fall, Spring, Summer)

PHYA-758 Family Practice
This mandatory rotation in the field of family medicine provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or PHYAST-BS or those students with graduate standing in PHYA-MS.) CLN 15, Credits 4 (Fall, Spring, Summer)

PHYA-759 Elective Rotation
This mandatory rotation in an elective field of medicine provides additional hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or PHYAST-BS or those students with graduate standing in PHYA-MS.) CLN 15, Credits 4 (Fall, Spring, Summer)

PHYA-761 Professional Practice I
This is the first in a sequence of courses designed for the physician assistant student in the clinical setting. The course will cover discipline specific areas including a pulmonary workshop and lectures on topics such as working with a pharmaceutical company, professionalism, and rehabilitative medicine. The course will also include an ongoing Evidence-Based Medicine (EBM) series and physician assistant national certification exam board review. (This class is restricted to students in PHYA-BS with at least 4th year standing or PHYAST-BS or those students with graduate standing in PHYA-MS.) Lecture 3, Credits 2 (Summer)

PHYA-762 Professional Practice II
This is the second in a sequence of courses designed for the physician assistant student in the clinical setting. The course will cover discipline specific areas including complementary medicine lectures and professionalism. The course will also include an ongoing Evidence-Based Medicine (EBM) series and physician assistant national certification exam board review. (Prerequisites: PHYA-761 or equivalent course.) Lecture 3, Credits 2 (Fall)

PHYA-763 Professional Practice III
This is the last in a sequence of courses designed for the physician assistant student in the clinical setting. The course will cover discipline specific areas including lectures regarding PA workforce issues, coding and billing, social service work and a resume writing workshop. The course will also include an ongoing Evidence-Based Medicine (EBM) series and physician assistant national certification exam board review. (Prerequisites: PHYA-762 or equivalent course.) Lecture 3, Credits 2 (Spring)
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CGLS-698 Glass Graduate Internship
Glass graduate internship is a course that offers students the chance to gain experience in professional environments, with the assumption that they may be determined through faculty counseling. This course leads to the master's thesis, presented by the student and approved by the faculty. (This class is restricted to students in the Glass-MFA program.) INT, Credits 1 - 6 (Fall, Spring, Summer)

CGLS-699 Glass Graduate Co-op
This course will examine professional opportunities present outside the major studio at RIT or other studios or educational institutions. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All Co-ops must fall within an RIT term (fall, spring, summer). (This class is restricted to students in the Glass-MFA program.) Co-op, Credits 0 (Fall, Spring, Summer)

CGLS-799 Glass Grad Independent Study
Glass Graduate Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty advisor will propose a course of study. Students will produce projects specific to their proposal. **NOTE: Student must have a minimum 3.0 GPA** (This course is restricted to CIAS Graduate students.) Independent Study, Credits 1 - 6 (Fall, Spring, Summer)

Metsals and Jewelry Design

CMTJ-630 Metals and Jewelry Design Elective III
An elective course providing graduate-level students an opportunity for introductory study in metals: either hollowware or jewelry. Students will gain an understanding of the history of metals. Development of metals techniques, design fundamentals and encouragement of personal expression are encouraged. The student will learn to evaluate new techniques, materials and concepts. Slide lectures, technical demonstrations, field trips, hands-on experience and critiques will be used. **Fee: There is a lab fee required for this course** (This course is restricted to CIAS Graduates.) Studio 6, Credits 3 (Fall, Spring)

CMTJ-698 Metals and Jewelry Design Graduate Internship
This internship is open to all Metals graduate students with a minimum of a 3.0 GPA. Metals students should first procure an internship opportunity within our industry. Students must submit a completed permission form identifying the firm and what they have been told will be their duties and responsibilities. All Metals and Jewelry Design Internships must be approved by the student’s Program Director or Administrative Chair. Students are required to submit a minimum 10-page paper about their experience and obtain a letter of review from their job site supervisor. 90 hours of work earns 1 semester credit. (Enrollment in this course requires permission from the department offering the course.) INT, Credits 1 - 6 (Fall, Spring, Summer)

CMTJ-699 Metals and Jewelry Design Graduate Co-op
The Metal and Jewelry Design Graduate Co-op will provide students with the option to work in the Metals and Jewelry Design Industry. Students may apply for co-op employment to businesses based on the availability of positions and business job needs. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All Co-ops must fall within an RIT term (fall, spring, summer). (Enrollment in this course requires permission from the department offering the course.) Co-op, Credits 0 (Fall, Spring, Summer)

CMTJ-887 Metals and Jewelry Design Graduate Part-time Coop
The Metal and Jewelry Design Graduate Co-op will provide students with the option to work in the Metals and Jewelry Design Industry. Students may apply for co-op employment to businesses based on the availability of positions and business job needs. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All Co-ops must fall within an RIT term (fall, spring, summer). (This class is restricted to students in the METAL-MFA program.) Co-op, Credits 0 (Fall, Spring, Summer)

Furniture Design

CWFDF-630 Furniture Design Elective III
This is a class designed for non-majors, covering a fundamental introduction to techniques and aesthetics of woodworking. Topics covered include the use of select hand tools and woodworking power tools, wood as a material, its basic properties and fundamental processes of wood fabrication. The course includes a prescribed project based on five in-class contact hours. **Fee: There is a lab fee required for this course** (This course is restricted to CIAS Graduate students.) Lecture/Lab 5, Credits 3 (Fall, Spring)

CWFDF-698 Furniture Design Internship
The Furniture Design Internship will provide students with the option to work in the furniture design or furniture manufacturing field. Students may apply for internships to businesses based on the availability of positions and business job needs. Students must obtain permission of an instructor and complete the Internship Permission Form to enroll. Registration with co-op and placement office also required. (Enrollment in this course requires permission from the department offering the course.) INT, Credits 1 - 6 (Fall, Spring, Summer)

CWFDF-699 Furniture Design Co-op
The Furniture Design Co-op will provide students with the option to work in the furniture design or furniture manufacturing field. Students may apply for co-op employment to businesses based on the availability of positions and business job needs. Furniture Design co-ops must be approved and sponsored by a faculty advisor. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All Co-ops must fall within an RIT term (fall, spring, summer). (Enrollment in this course requires permission from the department offering the course.) Co-op, Credits 0 (Fall, Spring)

CWFDF-799 Furniture Design Independent Study
Furniture Design Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty advisor will propose a course of study. Furniture Design students must obtain permission of an instructor and complete the Independent Study Form to enroll. **NOTE: Student must have a minimum 3.0 GPA** (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1 - 6 (Fall, Spring, Summer)

CWFDF-887 Furniture Design Part-time Coop
The Furniture Design Co-op will provide students with the option to work in the furniture design or furniture manufacturing field. Students may apply for co-op employment to businesses based on the availability of positions and business job needs. Furniture Design co-ops must be approved and sponsored by a faculty advisor. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All Co-ops must fall within an RIT term (fall, spring, summer). (WOOD-MFA) Co-op, Credits 0 (Fall, Spring, Summer)

Textiles

CWTLD-630 Quilting Graduate Elective
This course will introduce the beginner to the textile studio and to textiles as a creative material. Particularly the art of quilting. The students will acquire the ability to sew by hand and by machine. Lectures will include topics such as quilt design, fabric surface design, the history of quilting and techniques of quilting. **Fee: There is a lab fee required for this course** (This course is restricted to CIAS Graduate students.) Studio 6, Credits 3 (Fall, Spring)

CWTLD-799 Textiles Independent Study
Textiles Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty advisor will propose a course of study. (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1 - 6 (Fall, Spring, Summer)
Art Education

ARED-702  Inclusive Art Education: Teaching Students with Disabilities in the K-12 Art Classroom
Art Educators are expected to be able to understand the diverse learning needs of all students. Students in this course will discover how to adapt their own curricula and collaborate with special needs teachers to help students succeed in the art classroom. Through course work and field experience students will build a foundation of knowledge for working with children and youth with special needs. Students will develop new instructional strategies for making visual art more accessible for students with exceptionalities and a plan to incorporate accessibility strategies into their daily teachings. In a seminar format, the students realize the course objectives through participatory means. Students are expected to write critical essays, conduct research and field experience, and to participate in weekly small and large format discussion groups. On-line technology is utilized in addition to lectures, videos, and other forms of media. This course has a field experience component of 20 hours. (This course is restricted to VISART-MST students.) Lecture, Credits 3 (Fall)

ARED-703  Multicultural Issues in Art and Education
In this course students will explore a range of perspectives on multicultural issues in the visual arts and education fields. The focus will be on: making connections with contemporary multicultural art; the implementation of lesson plans based on multicultural issues for the art education classroom; and an examination of curriculum and policy issues. Resources from the areas of contemporary art, cultural studies, the visual arts, and education will be investigated. Students are expected to write critical papers and essays, develop curriculum resources, and to participate in weekly small and large format discussion groups. On-line technology is utilized in addition to lectures, videos, and other forms of media. (This course is restricted to VISART-MST students.) Lecture, Credits 3 (Fall)

ARED-704  Methods in Teaching and Learning
This course will explore the process of teaching art in the public school classroom at the Elementary level. Theories and practices relevant to teaching and learning in visual art will be addressed. Students will be encouraged to explore highly structured as well as highly experimental approaches to teaching art. Projects will include lesson-planning, unit planning, classroom management, investigating new technologies, urban education, action research, and other relevant topics, such as: human development, students with disabilities, multiple intelligences, assessment processes and personal inquiry as reflective practice. This course has a field experience component of 30 hours. (This course is restricted to VISART-MST students.) Studio, Credits 3 (Fall)

ARED-705  Methods II: Studio Thinking
This course explores the relationship between curriculum, instruction, and the assessment of learning. Students are introduced to process and procedures for developing curriculum, and assessing student learning in the art classroom, specifically at the secondary level. An emphasis is placed on a studio-thinking approach to teaching and learning. Students will explore innovative and creative approaches to curriculum design. Pedagogical knowledge is developed and extended through artistic practice and meaning making in lesson and unit development. This course compliments the course: Methods in Teaching and Learning. (This course is restricted to VISART-MST students.) Lecture, Credits 3 (Fall)

ARED-711  Professional Practices in Art Education
This course focuses on the development of professional practices for entry-level art educators who are involved in their student teaching practicum. The focus will be on understanding the requirements for entry into the field and reflecting on the day-to-day professional responsibilities of an art teacher in the K-12 classroom. Projects will include presentations, relevant readings, assessment practices, mock interviews, case studies, visiting speakers, and preparing materials for applications in the field of art education. Students will be expected to complete weekly assignments. Goals for excellence in teaching and State and National standards are investigated and addressed. In a seminar format, the students realize the course objectives through participatory means. On-line technology is utilized in addition to lectures, videos, and other forms of media. (This course is restricted to VISART-MST students.) Lecture, Credits 3 (Spring)

ARED-790  Student Teaching
The student teaching practicum is designed to provide the student teacher with depth pedagogical experiences, real world challenges, and rich learning opportunities. Two student teaching placements are arranged for each student for the duration of 6-7 weeks each. Full-time involvement at the school site is required. The Student Teaching Handbook is used as a guide to answer students' questions. Experienced mentor teachers and college supervisors. This experience includes observation, full-responsibility planning and teaching, and involvement in the culture of the school setting. Students are assigned a cooperating teacher and a college supervisor for each setting. A Student Teaching Handbook is provided. Students are required to meet state and national standards when teaching. Unit and work sample preparation, instruction and assessment are required. On-line technology is utilized in addition to lectures, video and other forms of media. (Prerequisites: ARED-702 and ARED-704 and ARED-705 or equivalent courses. Co-requisites: ARED-890 or equivalent course.) Studio, Credits 9 (Spring)

Art History

ARTH-601  Forms of Inquiry
Forms of Inquiry aim to expose students to a broad range of critical issues related to conception and production, to inspire and provoke critical reflection, and to facilitate the development of a preliminary thesis topic. Presentations, discussions, and written assignments will examine concerns from aesthetics, psychology, anthropology, philosophy, and critical theory as they relate to contemporary art, crafts, design and image making. (This course is restricted to CIAS Graduate students.) Lecture, Credits 3 (Fall, Spring)

ARTH-605  Thinking About Making: The Practice of Art in a Global Society
A discussion based art history elective for graduate students. The course seeks to bridge the gap between studio practice and contemporary art history. Students will explore very current work and ask questions about what is art, who is the audience, what is "our" art making practice and how does that fit within the larger context of the current state of the global art world. How do we measure success and artistic failure? The course emphasizes observation, critical analysis and written interpretation. (This course is restricted to students in the FNAS-MFA or VISART-MST or CCER-MFA or GLASS-MFA or WOOD-MFA or METAL-MFA or IMGART-MFA programs.) Lecture, Credits 3 (Fall, Spring)

ARTH-611  Extreme Abstraction
Although we can trace the roots of abstraction to non modern times and find its beginning as a concept in the visual arts in the late 18th and through-out the 19th century, it is a pre-dominantly 20th century phenomena. During the beginning of the 20th century there were many artists that turned to nonfigurative practices for reasons that were mostly cultural and political. The world was changing and the artists wanted art to change as well. Although these reasons were about creating new ways of seeing and representing the world the sources for these visions varied from artist to artist. Scientific discoveries dealing with concepts of evolution, geology, atomic theory and astronomy contributed to the artists theorizing and producing abstract works of art. And although the work took on a look that may have been associated with decoration, most artists denied this connection for fearing that their work would not be taken seriously. Merely decorative! Abstraction since then has gone through many manifestations. The artists of today are no longer just going through the process of abstracting but are now producing abstract work that has its own history, rules and grammar. Issues of science, spirituality, primitivism and the decorative still resonate in the work of late 20th and early 21st century artists. But what is different? (This course is restricted to CIAS Graduate students.) Lecture, Credits 3 (Spring)

ARTH-621  The Image
The image remains a ubiquitous, controversial, ambiguous and deeply problematic issue in contemporary critical discourse. Yet, it is also a key concern of visual culture, and a connecting problem across the entirety of CIAS (the College of Imaging Arts and Sciences) here at RIT where the production and consumption of images is paramount. This course will examine recent scholarship devoted to the image and the ideological implications of the image in contemporary culture. Topics will include: the modern debate over word vs. image, the mythic origins of images, subversive, traumatic, monstrous, banned and destroyed images (idolatry and iconoclasm), the votive and effigy, the mental image, the limits of visibility, the moving and projected image, the virtual image, image fetishism, the valence of the image, semiotics and the image, as well as criteria by which to assess their success or failure (their intelligibility) and their alleged redemptive and poetic power. (This course is restricted to CIAS Graduate students.) Lecture, Credits 3 (Fall, Spring)

ARTH-624  Scandinavian Modernism
This course examines the decorative arts and visual culture of modern Scandinavia from 1860 to the present, with special emphasis on the social, economic, and political impulses that have shaped them. Scandinavian Modern design plays a significant role in the postwar period; it is equated with such leading brands as Volvo, Saab, Ericsson, Nokia, H&M, Electrolux Orrefors, Georg Jensen, ARTEK, Iitala, and IKEA and the idea of progressive, social democracy. The myths and realities of its success will be examined, as well as its impact on contemporary design. (This course is restricted to CIAS Graduate students.) Lecture, Credits 3 (Fall, Spring)
ART-638 Symbols and Symbol Making: Psychoanalytic Perspectives on Art
This course explores the links between psychoanalytic theory and art history with special focus on the work of Sigmund Freud, Carl Jung, and their followers. A central aim is to examine the way in which psychoanalytic theory has been employed by art historians and theorists as a mode of interpretation, as well as to study how, why, and what several of the most notable psycho-analysts have written about art. Topics include the interpretation of dreams, transference, the Oedipal myth, melancholia, narcissism, abjection, the structure of the unconscious, the fetish, Archetypes and the Collective Unconscious, as well as outsider art and the art of the insane. Key theorists to be discussed include: Freud, Jung, D.W. Winnicott, Melanie Klein, Jacques Lacan, Otto Rank and Julia Kristeva; individual artists studied include: Albrecht Dürer, Leonardo da Vinci, Michelangelo, Edward Munch, Max Ernst, Jackson Pollock, Louise Bourgeois, Mary Kelly and Victor Burgin; in addition to examples from film (Maya Deren, Luis Bu-iel and Salvador Dalí, as well as Stan Brakhage). (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall, Spring)

ART-644 Illuminated Manuscripts
Students in this course will examine the history of illuminated manuscripts, learning about the working methods of artists as well as the cultural significance of the illuminated book. Issues of production, style, function, and patronage will be introduced, and students will explore the relationships between images, texts, and readers. (GRAD-CIAS) Lecture 3, Credits 3 (Fall, Spring)

ART-650 Topics in Art History
A focused, critical examination and analysis of a selected topic in Art History varying according to faculty teaching the course. A subtopic course description will be published each term course is offered. This course can be repeated. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall, Spring)

ART-663 Modern Architecture
In this course, we will explore the history of world architecture from the late nineteenth century to the present. Issues to be considered include the definition of “modern” as it applies to the built environment; new building types; historicism; stylistic movements; urban development; housing; modern material; critical theory and its impact on design; and architectural representation. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Spring)

ART-666 Modernism Realism Expressionism
This course is an inquiry into one of the major debates of modern art. This debate had a seemingly clear victor. The idea that the artist expresses his or her individuality and then communicates that “self” to the rest of “humanity” through a higher, transcendent, language has dominated the discourse and practice of modernist art. In retrospect, the art that dominated most of the first half of the 20th century was of an Expressionist nature. On the other hand art that addressed the social and in anyway addressed direct and specific social issues was banished by art’s major institutions. Realism was dead. In this course we will look at the circumstances of how Realism became subordinated to Expressionism. We will also address the question of what exactly constituted the practice of realist art. We will look at the roots of both movements that will take us at times into 18th and 19th centuries. But mostly we will concentrate on how institutions like the Museum of Modern Art helped define how we see the history of 20th century art as being determined. We will also explore how Modernism’s “other”, Realism, survived and gained new currency in practices of late 20th and early 21st century art. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall)

ART-668 Art and Technology: From the Machine Aesthetic to the Cyborg Age
This course explores the link between art and technology in the 20th century with special focus on the historical, theoretical, and ideological implications. Topics include the body in the industrial revolution, utopian, dystopian, and fascist appropriations of the machine, engendering the mechanical body and machine-eroticism, humanism, the principles of scientific management, and the para-noiac machine, multiples, mass production, and the art factory, industrial design and machines for living, the technological sublime, cyberpunk and the posthuman. Key theorists to be discussed include: Karl Marx, Norbert Weiner, Reyner Banham, Siegfried Giedion, Michel Foucault, Deleuze and Guattari, Donna Haraway, and Martin Heidegger, as well as examples from film (Modern Times, Metropolis, Man with the Movie Camera and Blade Runner) and literature (Shelley’s Frankenstein, Zamytain’s We). Artists covered include: Tatlin, Rodchenko, Malevich, Moholy-Nagy, Legée, Sheeler, Picabia, Duchamp, Calder, Ernst, Le Corbusier, Klee, Tinguely, Oldenburg, Rauschenberg, Warhol, Beuys, Kiefer, Lewitt, Fischli and Weiss, Acconci, Nam June Paik, Survival Research Laboratories, Bureau of Inverse Technology, Stelarc, Orlan, Dara Birnbaum, Roxy Paine, Marina Abramovic, Eduardo Kac and Bill Viola. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall)

ART-671 Art and Architecture of Ancient Rome
In this course, students will examine the visual culture of ancient Roman civilization from the foundations of Roman culture through the Late Imperial era. Roman culture was heavily reliant on images as a means of transmitting concepts of lineage, status, and power; students will learn how these images may have been perceived in the context of Roman social and political history, and how style may have been used as an ideological tool. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall)

ART-672 Art of the Americas
This is a survey course of Native North and South American visual arts within an historical and anthropological framework. Included will be an examination of the development of principal styles of Ancient American architecture, sculpture, painting, and ceramics up to the sixteenth century when the Spanish conquistadores defeated the Aztec and Inca empires and imposed colonial rule. Consideration is also given to materials used, techniques of construction, individual and tribal styles, as well as to the meaning and function of various art forms within Native American societies. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall)

ART-673 Conceptual Art
This course examines the widely influential mid-1960s art movement that questioned the fundamental nature of art itself by renunciating the material art object as well as the phenomenon of art making. The definition of art as well as its institutional framework was thereby expanded, and the idea, concept, or intellectual dimension of the work was underscored. Students will be acquainted with the philosophical foundations and critical implications of this global movement across a wide spectrum of works and practices (paintings, performance, installations, books and texts, photography, film, and video) and its relevance to contemporary concerns. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall)

ART-674 Dada and Surrealism
This course examines the widely influential Dada and Surrealist movements in Europe and the United States from 1916 through the post-World War II period as well as their relevance to contemporary concerns. Emphasis is on identifying the major works of artists involved in these movements as well as their philosophical foundations, critical implications, as well as broader literary and ideological contexts (e.g. Freud, Breton, Lautréamont, Leiris and Bataille). A wide range of works and practices (paintings, performance, installations, literary texts, photography, film, and ephemeral objects) will be studied, and the work of certain key artists (Hoch, Heartfield, Schwitters, Duchamp, Picabia, Picasso, Dalí, Ernst, Giacometti, Man Ray, Bellmer, Cahun, Cornell, Magritte, Miro, Oppenheim, Toyn and Picasso) will be analyzed in depth. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall, Spring)

ART-675 Early Medieval Art
This class will examine European artistic production — including architecture, architectural and free standing sculpture, metalwork, painting, and manuscript illumination — from the sixth to the twelfth centuries. The visual culture of the period will be analyzed in relation to the historical, social, and political context of its production. Primary issues to be considered include architectural structure, art and religious practice, the status and organization of artists and builders, art as an expression or enforcer of identity, the question of regional styles, contact with other cultures, and the relationship between medieval art and the past. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall, Spring)

ART-677 Displaying Gender
This course brings together two of the most significant strains of recent art historical scholarship: the study of gender in representation and the critical examination of exhibitions and museums — with particular focus given to key examples of curatorial practice from the late 19th century to the present day. Through readings, possible museum visits, class discussions, and guided individual research, questions of gender in exhibitions will be considered in relation to other aspects of identity including sexuality, race, and class. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Spring)

ART-678 Edvard Munch
The Norwegian artist Edvard Munch (1863-1944) continues to generate a great deal of popular interest, critical scholarship, and reflection. The four-volume catalogue raioussé of his paintings was published in 2009, and the graphic work appeared in 2001. A painter, printmaker, photographer, and filmmaker, Munch was also a prolific writer, well acquainted with the symbolist poets and playwrights, as well as the broad intellectual drift of the fin-de-Siècle. He is the one Scandinavian artist included within the Modernist canon and his image, The Scream (1893), is an icon of the modern age. Munch traveled widely throughout Europe and his work was exhibited in North America beginning with the famous 1913 Armory Show. This course will examine recent scholarship devoted to Munch and the critical issues that his work addresses. It will also place him within the broader cultural context of Scandinavian and European modernism, while examining his impact on subsequent generations. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall, Spring)

ART-681 Latin American Art
This is a survey course of the historical development of the art of Latin America from colonial times to the present. Included will be a consideration of painting, sculpture, architecture, graphic, and photographic arts. Potential themes to be addressed include the dependence on the European neo-classical academic model; indigenism; nationalism and the resurgence of “popular” art; the role of the visual arts in the construction of history; the conflicts and tensions involved in the search for a cultural identity. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Spring)
ARTH-682 Medieval Craft
In this course, we will explore the history of craft production throughout the Middle Ages. While modern scholars have often divided “art” from “craft,” this distinction did not exist in medieval Europe: artists were craftsmen, producing objects that were both practically and symbolically functional. This class will focus on the decorative arts including stained glass, ivories, textiles, and metalwork—to produce a more integrated picture of medieval visual culture. Students will study both practical aspects of production and the reception and meaning of these objects within medieval society. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall, Spring)

ARTH-683 Installation Art
This course will introduce students to historic, contemporary, and critical issues surrounding installation art. There will be an introduction to the development of installation art as a genre. We will examine the changes, which have developed over the past three decades, of object sculpture to non-object. There will be an emphasis on the development of the concept of an installation project and its relationship to site and/or audience. Both public and gallery spaces will be discussed. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall)

ARTH-684 Late Medieval Art
This course will examine architecture, sculpture, painting, and decorative arts in Europe from the mid-thirteenth to the sixteenth century. Students will analyze the visual culture of the period in relation to the historical, social, and political contexts of its production. Primary issues to be considered include the concept of Gothic, architectural design and construction, the format, function, and creation of manuscripts, art and religious practice, the status and organization of artists, artistic patronage, regional styles, and cross-media influences. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall)

ARTH-687 The Gothic Cathedral
This class will examine the Gothic cathedral and related art production (stained glass, sculpture, and metalwork within the cathedral context) from the twelfth through the fifteenth century. The cathedrals of the late middle ages represent the greatest efforts of medieval art production; students will study these buildings within their cultural contexts and examine the meanings such buildings conveyed to their intended audiences. The class will explore the design, structure, and construction of Gothic cathedrals throughout Europe, and will also examine the decorative programs of sculpture, stained glass, and liturgical objects integral to the meaning and function of these structures. Issues to be considered include the production of cathedrals; the stylistic variations of Gothic; the relationship between function and form; the urban context of Gothic cathedrals; and the holistic view of the Gothic cathedral. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall, Spring)

ARTH-711 Theories of Representation
Representation is the fundamental practice underlying the visual arts. In this graduate course, students will explore theoretical concepts, processes, meanings, and functions of visual representation across different cultures, eras, and media, analyzing how, why, and to whom representation communicates meaning. This course will be reading intensive, and group discussion will be the primary pedagogical method. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall)

Fine Arts Studio
FNAS-601 Fine Arts Studio: New Forms
Graduate students in the Fine Arts Studio program may choose any combination of Fine Arts Studio: Painting, Non-Toxic Printmaking, Sculpture or New Forms) classes to meet the 24 credit course requirements in their major. This course is designed to introduce advanced non-toxic printmaking technical concepts that may include non-toxic printmaking techniques such as Intaglio-Type, screen, relief, monoprint, digital transfer, halftone, photo and the art of the master printer. The focus will be on the creation of intaglio printmaking research and how to creatively apply techniques that will result in sophisticated works of art. (FNAS-MFA) Studio 5, Credits 3 (Fall, Spring)

FNAS-602 Fine Arts Studio: Non-Toxic Printmaking
Graduate students in the Fine Arts Studio program may choose any combination of Fine Arts Studio: Painting, Non-Toxic Printmaking, Sculpture or New Forms) to meet the 24 credit course requirements in their major. Any course may be repeated. This course is designed to introduce advanced non-toxic printmaking technical concepts that may include non-toxic printmaking techniques such as Intaglio-Type, screen, relief, monoprint, digital transfer, halftone, photo and the art of the master printer. The focus will be on the creation of intaglio printmaking research and how to creatively apply techniques that will result in sophisticated works of art. (FNAS-MFA) Studio 5, Credits 3 (Fall, Spring)

FNAS-603 Fine Arts Studio: Painting
Graduate students in the Fine Arts Studio program may choose any combination of Fine Arts Studio: Painting, Non-Toxic Printmaking, Sculpture or New Forms) classes to meet the 24 credit course requirements in their major. Any course may be repeated. Fine Arts Studio: Painting students engage in a personal exploration of techniques in painting to advance their understanding and practice of visual art. Individual approaches to painting from the representational through the abstract present a cross section of current art issues which students must address as they build their portfolios. (FNAS-MFA) Studio 5, Credits 3 (Fall, Spring)

FNAS-604 Fine Arts Studio: Sculpture
Graduate students in the Fine Arts Studio program may choose any combination of Fine Arts Studio: Painting, Non-Toxic Printmaking, Sculpture or New Forms) to meet the 24 credit course requirements in their major. Any course may be repeated. Fine Arts Studio: Sculpture, This course allows students to explore concepts, materials, processes, and techniques to develop a personal, cohesive three-dimensional body of work. Theories and history of sculpture will be discussed as relevant to individual directions. (FNAS-MFA) Studio 5, Credits 3 (Fall, Spring)

FNAS-607 Non-Toxic Printmaking I
This course is part of a two-part Graduate Certificate in Non-Toxic Printmaking for highly motivated students who are able to sustain their work independently. This course is designed to introduce basic non-toxic printmaking technical concepts that may include techniques such as Intaglio-Type, A.R.E., screen, relief, monoprint, digital transfer, halftone, photo and the art of the master printer. The focus will be on the creation of intaglio printmaking research and how to creatively apply techniques that will result in sophisticated works of art. (NTIPR-CT) Lecture 2, Studio 4, Credits 6 (Fall)

FNAS-608 Non-Toxic Printmaking II
This course is part of a two-part Graduate Certificate in Non-Toxic Printmaking for highly motivated students who are able to sustain their work independently. This course is designed to introduce advanced level non-toxic printmaking technical concepts that may include one or more of the following techniques; Intaglio-Type, A.R.E., screen, relief, monoprint, digital transfer, halftone, polyester plate litho, photo and the art of the master printer. The focus will be on the creation of intaglio printmaking research and how to creatively apply techniques that will result in more sophisticated works of art. (NTIPR-CT) Lecture 2, Studio 4, Credits 6 (Spring)

FNAS-614 Ideation and Series
Ideation and Series Creative flow, having an endless stream of ideas, alternatives, and choices for solutions, helps creative work evolve and reach more advanced levels. In this course students develop appropriate skills and strategies to generate ideas and develop them effectively. (This course is restricted to CIAS Graduate students.) Studio 5, Credits 3 (Fall)

FNAS-631 Non-Toxic Printmaking for Non-Majors
This course is designed to introduce non-toxic printmaking concepts and techniques. (This course is restricted to CIAS Graduate students.) Studio 6, Credits 3 (Fall)

FNAS-633 Painting for Non-Majors
Students will be encouraged to experience and explore the properties of Oil Painting and establish strategies toward solving problems of composition related to successful form content. (This course is restricted to CIAS Graduate students.) Lecture/Lab 5, Credits 3 (Spring)

FNAS-635 Art Gallery Management
The complex social and cultural roles of a fine arts gallery will be explored through supportive gallery operations: the installation of experimental and traditional exhibits, promotion and marketing for competitions, student initiatives and special events tailored to the RIT and larger Rochester community arts audiences. Metro site visitations and gallery research will be combined with arranged studio hours in a gallery laboratory setting. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall, Spring)

FNAS-638 New Forms for Non-Majors
New Forms for Non-Majors is designed to introduce students who are not in the Fine Arts Studio program to some of the new possibilities for personal expression outside of or beyond traditional drawing, painting, printmaking and sculpture. The students’ expertise from other fields can be channeled into forms of personal, fine art expression. (This class is open to graduate students in CIAS except those with majors in FNAS-MFA.) Studio 6, Credits 3 (Spring)
FNAS-643  Foundry Practices
This course is designed to introduce or develop students’ skills in casting metals with an emphasis on cast iron and the use of a cupola. Advanced pattern-making, mold-making, sprueing, patination, and casting techniques will be introduced. Students will develop their concepts through cast metal sculpture. (This course is restricted to CIAS Graduate students.) Lecture/Lab 5, Credits 3 (Spring)

FNAS-650  Topic in Fine Arts Studio
A focused immersion into a selected traditional or contemporary process, technique, medium or material used in the creation of artwork varying according to faculty teaching the course. A subtopic course description will be published each term the course is offered. This course can be repeated. (GRAD-CIAS) Studio 6, Credits 3 (Fall, Spring)

FNAS-660  Watercolor
An exploration of watercolor concepts and techniques to enhance skill development and personal expression of the individual student. (This course is restricted to CIAS Graduate students.) Lecture/Lab 5, Credits 3 (Fall, Spring, Summer)

FNAS-661  Digital Art Printmaking
This class allows students to gain experience and practice using popular software and digital tools for visualization of their art. Students will use printmaking processes to complete a selection of prints that demonstrate knowledge of digital production and to analyze, extend, and improve their capacity as fine artists. (This course is restricted to CIAS Graduate students.) Lecture/Lab 5, Credits 3 (Fall)

FNAS-663  Contemporary Drawing
Emphasis is on drawing and the development of form, space and expression from a variety of sources, including the human figure. Emphasis on basic techniques, materials, and concepts for further study are explored. (This course is restricted to CIAS Graduate students.) Studio 6, Credits 3 (Spring)

FNAS-668  Monoprint Figure
Life drawing exercises focus on dynamic and expressive line quality. Half of the class time will be dedicated to life drawing and the other half to monoprinting. The focus will be on creative techniques that result in works of art. (This course is restricted to CIAS Graduate students.) Studio 6, Credits 3 (Spring)

FNAS-671  Painting the Figure
The course explores materials and techniques in painting the human form. We build on the theory and practice of color and drawing as well as other resources to develop an understanding of how to portray the figure. Traditional and contemporary approaches to figurative painting are examined. Students are instructed to complete a set of paintings and drawings that demonstrate their understanding of form, color and composition. (This course is restricted to CIAS Graduate students.) Lecture/Lab 5, Credits 3 (Fall)

FNAS-673  Figure Sculpture
Through the use of live models the student will develop an understanding of the human form through the creation of multiple armatures and oil clay maquettes. The student will then create a series of castings pulled from the accumulated experience with the model. (This course is restricted to CIAS Graduate students.) Lecture 2, Studio 4, Credits 3 (Spring)

FNAS-683  Welding and Fabrication
This course is designed to introduce or develop students’ skills in metal fabrication. Several different types of equipment will be introduced and explained along with the welding and cutting processes. Emphasis will be placed on students completing a body of work consisting of finished steel fabricated sculptures. The course will be taught off-campus at Mahany Welding, 115 Fedex Way, Rochester, NY. **Fee: There is a $200 lab fee to cover personal equipment and supplies** (This course is restricted to CIAS Graduate students.) Lecture/Lab 5, Credits 3 (Spring)

FNAS-698  Fine Arts Studio Internship
The Fine Arts Studio Internship will provide students with the opportunity to work with established artists or in fine art related businesses. Students may apply for internships to businesses based on the availability of positions and business job needs. Students must obtain permission of an instructor and complete the Internship Permission Form to enroll. (Enrollment in this course requires permission from the department offering the course.) INT, Credits 1 - 6

FNAS-699  Fine Arts Studio Co-op
The Fine Arts Studio Co-op will provide students with the opportunity to work with established artists or in fine art related businesses. Students may apply for Co-ops to businesses based on the availability of positions and business job needs. Students must obtain permission of an instructor and complete the Co-op Permission Form to enroll. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All Co-ops must fall within an RIT term. Permission of instructor. (FNAS-MFA) Co-op, Credits 0 (Fall, Spring)

FNAS-702  Fine Art Research
Graduate students prepare for the written component of the thesis through practice with research, critical judgment, and development of outlines and essays. Contemporary art issues are clarified through discussion and readings in art history, art criticism, artist statements and interviews. Fine Arts studio students are required to take this course spring semester before advancing to the Thesis credits. (FNAS-MFA) Lecture, Credits 3 (Spring)

FNAS-730  Developing an Online Brand
This course will provide a comprehensive exploration of the planning, building, and managing website and social media. The course will include instruction on creating, publishing and managing content for internet self-promotion as well as ways to use social media to create new opportunities. Students will be encouraged to explore and develop effective approaches to documenting their processes of making and portfolios for online publishing. (This course is restricted to CIAS Graduate students.) Studio 6, Credits 3 (Fall, Spring)

FNAS-799  Fine Arts Studio Independent Study
Fine Arts Studio Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty advisor will propose a course of study. Fine Arts Studio Independent Study students must obtain permission of an instructor and complete the Independent Study Permission Form to enroll. **NOTE: Student must have a minimum 3.0 GPA ** Independent Study, Credits 1 - 6 (Fall, Spring)

FNAS-887  Fine Arts Studio Part-time Coop
The Fine Arts Studio Co-op will provide students with the option to work with established artists or in fine art related businesses. Students may apply for Co-ops to businesses based on the availability of positions and business job needs. Students must obtain permission of an instructor and complete the Co-op Permission Form to enroll. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All Co-ops must fall within a RIT term (fall, spring, summer). (FNAS-MFA) Co-op, Credits 0 (Fall, Spring, Summer)

FNAS-890  Research and Thesis
After creating a body of artwork derived from the student’s thesis proposal, the student must exhibit this work in a gallery. In the exhibition space, during this show, the student will meet with the thesis committee to examine the success of the artwork in relation to the proposal. The student will be expected to orally present and defend the ideas explored through the artwork. The student will conclude the thesis process by explaining the work and putting it into both a personal and artistic context in a written and published document. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 10 (Fall, Spring)

FNAS-892  Continuation of Thesis Fine Arts Studio
The Fine Arts Studio Continuation of Thesis course provides student additional semester(s) to complete their thesis research, project, and thesis document. (Prerequisite: FNAS-890 or equivalent course and student standing in the FNAS-MFA program.) Continuation, Credits 0 (Fall, Spring)

ILLS-659  Illustrative Design
Illustrative Design is an introduction to the principles and methods used to incorporate illustration with typography and layout. Students will conceptualize, organize and execute illustrations within a design context. Illustrative Design I will emphasize the use of graphic elements such as symbols, charts, and type to be incorporated into illustrations. Layout terminology and illustration production methods will be included. Projects will expose students to various examples of real-world assignments that will demand the use of traditional illustration methods as well as computer-based production media. Assignments will stress solutions that are typically managed by art directors and designers. The course will emphasize the language of visualization and the relationship and coordination of concept, illustration and word. (This course is restricted to CIAS Graduate students.) Studio 6, Credits 3 (Fall)

ILLS-662  Journalistic Illus Grad
This course will familiarize students with the requirements of researching and visually reporting a specific happening or event. Assignments will be longer in duration and will consist of several real-world assignments that will demand the use of traditional illustration methods as well as computer-based production media. Assignments will stress solutions that are typically managed by art directors and designers. The course will emphasize the language of visualization and the relationship and coordination of concept, illustration and word. (This course is restricted to CIAS Graduate students.) Lecture/Lab 5, Credits 3 (Spring)
This course will explore the application of design methods and skills to projects addressing large-community and global problems requiring team-based, trans-disciplinary collaborations. (Studio, Credits 3 (Fall, Spring))
IDDE-706 Integrated Design Visualization
The second of a two-semester visualization sequence, this course further develops analog and digital visualization techniques, while expanding on graphic and three-dimensional components needed to create effective presentations and the workflows to achieve them. Assignments will also include crafting visual and verbal presentations that can be used to sell the VISCOM idea. (Prerequisites: IDDE-705 or equivalent course and a student in the IDDE-MFA program.) Lecture 2, Studio, Credits 3 (Spring)

IDDE-711 Design Research and Proposals
This course focuses on developing research skills in the field of design. Emphasis is placed on an exposure to a wide range of methods, research sources, data collection, and evaluation. Students will select and plan a design research topic, conduct a search for background material, construct a proposal, and defend their research topic. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA, CMGD-MFA and IDDE-MFA programs.) Lecture 3, Credits 3 (Spring)

IDDE-790 Thesis Research and Planning
The first of a two-course thesis sequence, the focus of this course is on establishing content, planning, scheduling, and research seeking innovative solutions through the process of concept development, ideation, and in-process evaluation. Final articulation of the project is approved by a faculty committee, presented in a graduate thesis show and accompanied by a written document that addresses how the theories and methods used in the project impact the current and future state of design in society. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 6 (Fall)

IDDE-799 Industrial Design Independent Study
Industrial Design Independent Study provides students the means to study in a specialized area with an individual faculty member. With the assistance of their a faculty advisors, Students, will propose a course of study. Students must obtain permission of an instructor and complete the Independent Study Permission Form to enroll. **NOTE: Student must have a minimum 3.0 GPA ** (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1-6 (Fall, Spring)

IDDE-887 Industrial Design Part-time Coop
The industrial design co-op provides students the option to work full time in the industrial design field. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All Co-ops must fall within an RIT term (fall, spring, summer). (This course is restricted to students in IDDE-MFA.) Co-op, Credits 0 (Fall, Spring, Summer)

IDDE-890 Thesis: Implementation and Evaluation
The second of a two-course thesis sequence, this course focuses on continued concept development of a thesis, concluding with the implementation and retrospective evaluation of chosen design problem. Solution is presented in a public exhibition, complemented by a written articulation of how the theories and methods employed in the project impact the current and future state of design in society. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 6 (Spring)

IDDE-892 Continuation of Thesis Industrial Design
The Industrial Design Continuation of Thesis course provides student additional semester(s) to complete their thesis research, project, and thesis document. (Prerequisite: IDDE-890 or equivalent course and student standing in the IDDE-MFA program.) Continuation, Credits 0 (Fall, Spring)

Visual Communication Design

VCDE-617 Experimental Workshop
The course focuses on implementing advanced, newly developing ideas in visual communication design. The specific subtopic for this course varies each time it is taught. As a result it may be repeated with a different subtopic. The subtopic is determined by the instructor. Potential topics include the creation of interactive installations, adaptive/responsive interface design, tangible media design, digital performances, cyber fashion, network art, locative media, scientific visualization, information visualization, event design, projection design, or any new area in digital design. Students can take more than one Experimental Workshop in a term, as long as the subtopic is not repeated. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture 2, Studio 3, Credits 3 (Fall, Spring)

VCDE-621 Character Design and Rigging
This course covers first the design of characters and then the creation of them using three-dimensional software, inverse kinematics, parent and rigid binding, bones, and deformers. Students design characters using techniques like interpretant matrices, model sheets, sketches, and maquettes followed by development of the actual character in software. Characters are designed for incorporation into motion graphics, games, real time applications, performance, or visualization. (Prerequisites: VCDE-706 or equivalent course.) Lecture 2, Studio 2, Credits 3 (Fall)

VCDE-626 Physical Interface Design
This course covers the use of basic electronics so that students can develop embedded systems or controllers for games, design environments with ambient intelligence, design interactive museum exhibits and point of purchase installations, or embed electronics in clothing. Students use micro controllers, sensors, switches, lights, and motors to implement their designs. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture 2, Studio 2, Credits 3 (Spring)

VCDE-627 Real Time Design
In this course, students design levels for games or virtual worlds for a variety of applications. Once the design is complete, the design is implemented using high-end three-dimensional software. In many cases the projects will be large and will be executed by teams of students. Versioning systems will be used to keep track of the most recently developed assets. Models are imported into real time software engines for manipulation. (Prerequisites: VCDE-706 or equivalent course.) Lecture 2, Studio 2, Credits 3 (Fall, Spring)

VCDE-628 3D Particles and Dynamics
This course focuses on three-dimensional special effects using 3D software in combination with other techniques. Course content addresses particle systems and dynamic simulations in a 3D environment. Physical reality concepts such as water flow, air movement, smoke, clouds, fire, and gravitational effects are explored in relation to their effects on cloth, hair, and fluids. Students will incorporate these dynamic simulations in practical design contexts for film, broadcast, and online. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture, Studio, Credits 3 (Spring)

VCDE-633 Hard Surface Modeling
The course focuses on designing and constructing hard surface models including machinery, furniture, vehicles, electronics, and robots. Students explore the use of different modeling techniques in the process and are particularly interested in the flow of the topology within the geometry. Some attention is given to creating controls for moving the hard surface models. (Prerequisites: VCDE-706 or equivalent course.) Lecture 2, Studio 2, Credits 3 (Fall)

VCDE-666 Design History Colloquium
This course is about scholarly issues such as critical thinking, analysis, expression, rigorous questioning, discussion, and dialogue. The course seeks to stimulate a deeper interest in scholarly approaches for graduate students who share an intellectual curiosity about the history of design and seek to expand their knowledge in the emerging field of design studies through a dynamic interplay of design history, design theory and design criticism as these central elements are focused on design objects or artifacts. The Vignelli Center for Design Studies and the Cary Graphic Design Archive offer unique archival resources to support research and interpretive course objectives. The aspect of a colloquium is “a gathering of graduate students who share an intellectual curiosity about the history of design and seek to expand their knowledge in the emerging field of design studies.” The course objectives are realized through lectures, field trips, guest speakers, archive visits and required research and writing projects. Using a case study format, the course content will focus primarily on the seminal people, places and products of the Modern design movement. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall, Spring)

VCDE-698 Visual Communication Design Internship
The Visual Communication Design Internship will provide students with the option to work in the visual communication design field. Students may apply for internships to businesses based on the availability of positions and business job needs. Students must obtain permission of an instructor and complete the Internship Permission Form to enroll. (Enrollment in this course requires permission from the department offering the course.) INT, Credits 1 - 6 (Fall, Spring)

VCDE-699 Visual Communication Design Co-op
The Visual Communication Design Co-op will provide world real, on the job experience for students wishing to gain experience at visual communication design. Students will apply and be hired by firms to enhance student’s career readiness. Visual Communication Design Co-ops must be approved and sponsored by a faculty advisor. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All Co-ops must fall within an RIT term (fall, spring, summer). (Enrollment in this course requires permission from the department offering the course.) Co-op, Credits 0 (Fall, Spring)

VCDE-701 Design History Seminar
This seminar focuses on a basis in the history of design, which complements the overall graduate studies in the School of Design. Interdisciplinary in nature, the course is thematic and emphasizes performance on the part of the student in dynamic dialogue on course topics. The course content focuses on subjects relative to the history of design (people, processes, products, and places), critical thinking and contextual historical issues. Students are expected to write critical essay and questions and to participate in weekly discussion groups. On-line technology is utilized in addition to slide lectures. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA, CMGD-MFA and IDDE-MFA programs.) Seminar 3, Credits 3 (Fall)
VCDE-706  3D Modeling and Motion
This course is an introduction to digital three-dimensional visualization. Students learn all aspects of 3D design, from modeling all the way through rendering the final images to setting keyframes for animation. Once familiar with the basics of production, students are encouraged to focus on specific topics such as lighting and texturing and the creation of visual effects for gaming, broadcast, visualization and education. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture, Studio, Credits 3 (Fall)

VCDE-707  Web and UI Design
This course provides an in-depth look at human-centered interface design. Students develop interactive web pages with functional design and usability for e-commerce, education, and the communication of visual communication. Emphasis is placed on the integration and application of design skills applied to information architecture, user navigation and orientation. Projects are focused on designing alternative navigational solutions for online Web applications and touch-screen devices such as mobile phones and touch-pads. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture, Studio, Credits 3 (Fall)

VCDE-708  Typography
This course examines the historical, theoretical, and perceptual aspects of typography for print and screen use. Grid structure, composition, hierarchy, message conveyance, and formal aspects of typographic design are explored with an emphasis on developing harmonious type and image integration into cohesive, sequential design applications. How temporal structural elements such as rhythm and pacing affect visual communication in a dynamic medium is also investigated and applied. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture 2, Studio 3, Credits 3 (Fall)

VCDE-709  Digital Design in Motion
This course focuses on motion design from story reels to the final project. Course content focuses on visual components, and assignments translate production techniques used in traditional filmmaking into the online environment. This includes the use of line, space (two and three-dimensional), composition and framing, simulated camera movements, color, and sound. Using a time-based application as the authoring tool and the techniques outlined in this course, students will be able to produce interactive stories, such as online graphic novels and webisodes. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture 2, Studio 3, Credits 3 (Fall)

VCDE-711  Design Theory and Methods Seminar
This seminar explores cross-disciplinary principles, theories and methods that can be used by designers. Through selected readings from current periodicals, critical writing, hands-on involvement, presentations and guest lectures, students will broaden their awareness of topics such as systems thinking, human factors, semiotic theory, and visual rhetoric, and become familiar with brainstorming, problem solving and evaluation methods in order to sharpen their understanding of the design process. Information will be directed toward meaningful concept development and the selection and use of appropriate methodologies for design problem solving. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs and IDDE-MFA programs.) Lecture, Credits 3 (Spring)

VCDE-717  Design Systems
This course investigates a systems thinking approach for the purpose of clear, unified communication. The complexity of multiple components are integrated into a common framework to solve graphic design problems. Conceptual mapping, design process strategies, user-centric goals, visual symbolism, the balance of design with cultural, environmental and technological factors, design writing, and design evaluation are integrated into the course. Both theoretical and applied problems will be developed. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Studio, Credits 3 (Spring)

VCDE-718  Project Design and Implementation
This course provides students with the necessary skills to further develop a research plan into a specific design inquiry with an application component. Emphasis is placed on identifying connections and integrating content between this course and the culminating first-year experience in the MFA Visual Communication Design program. Students will choose a topic, write a design proposal, and design and implement a project from inception to conclusion. This involves research, development, evaluation, refinement, completion of a finished creative project, and documentation of the process. The project can be produced independently or collaboratively with advice from the instructor. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lab 3, Lecture 2, Credits 3 (Spring)

VCDE-723  Interaction Design
This course applies design methodologies to multimedia applications. Students communicate ideas and information to specific audiences through interactive, instructional applications. Course work will integrate content research, developing measurable objectives, and information architecture with interactivity. At the completion of this course students will be able to design site maps and flowcharts, implement an effective graphical user interface, communicate layered information through a hierarchical structure, control user navigation and feedback using interactivity, and design cross-platform projects for entertainment, games, information systems, and education. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture, Studio, Credits 3 (Spring)

VCDE-728  Motion Graphics
This course focuses on motion graphics as an extension of traditional design that incorporates a temporal or time-based element into the message. Students are exposed to video composing software and learn the craft, practice, and theory of what it takes to make it in the fast-paced, competitive world of motion graphics design. Computer software is used to compose visual effects in both animation and live video. Sequencing, storyboarding, digital audio, titling, and animation are integrated to produce time-based projects for film, broadcast, and the web. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture, Studio, Credits 3 (Fall)

VCDE-731  3D Visual Design
This course focuses on the visual look of a three-dimensional model. Students apply lighting methods to illuminate 3D models and spaces. The interaction of light and pigment, use of light in painting, photography, and film are explored. Techniques in using shading networks are incorporated into the projects. Displacement textures are used to create detail in models. This course also covers a contrast and comparison of various methods and resolutions of rendering and outputting information from 3D software. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture, Studio, Credits 3 (Fall)

VCDE-732  Branding and Identity Design
This course provides an examination of the role of design in brand strategy and cohesive identity systems. Historical and current systems will be researched and analyzed. Development of formal proposals, research, and design strategies for developing integrated solutions are explored. Projects will include client contact, writing of design briefs, collaborative projects, use of social networks for brand expansion, information structures, screen and print formats, and presentation methods. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture, Studio, Credits 3 (Fall)

VCDE-733  Digital Media Integration
This course uses digital video cameras for motion recording and microphones for digital audio recordings. Emphasis is placed on digital video and audio design, production, and integration in multimedia applications. Course projects focus on shooting, digitizing and editing video plus recording, editing and mixing of audio for digital movies. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture, Studio, Credits 3 (Fall)

VCDE-741  Experiential Graphic Design
This course focuses on the functions of environmental graphic design in a three-dimensional environment. Through studies of theory of environmental design, exploration and conceptual development, design solutions are directed to assist users in navigating, or “wayfinding,” through a space or environment, to identify, direct and inform. Topics include learning methods, communication theory, ergonomics, visual hierarchy, design principles and process. Areas of application include architectural graphics, signage systems, dynamic environments, mapping, exhibit design, museum experiences, and themed environments. Students also explore how to integrate both two- and three-dimensional components to develop physical and digital-based environments. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture, Studio, Credits 3 (Fall)

VCDE-742  Information Design
This course explores the importance of reader and user responses to written and visually presented information. Problem-solving, functional requirements, information transmission, accessibility and design structure are integrated while investigating a variety of formats (i.e. charts, diagrams, business forms, tables, maps, instructional materials, wayfinding systems, and technical data.) Applied problems are solved through principles of language, structure, diagrammatic interpretation and the visual display of information. Solutions will be developed for both print media and digital use (i.e. mobile devices, computer screens, kiosks, etc.). (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Studio, Credits 3 (Fall)
VCDE-746 Professional Practices
The course will integrate concepts taught in the Design History Seminar and the Design Theory & Methods Seminar to help students prepare for a professional career in design. Equally as important as design theory, the content focuses on the practical knowledge of production and design skills, and exposure to basic business practices. An overview of business and economics related to the design world, goal setting and productivity skills, professional ethics, marketing, the interviewing process, and strategic analysis is addressed. Projects provide an in-depth look at creating an effective digital portfolio and curriculum vitae based upon personal strengths and interests, with professional standards, and career expectations in mind. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Lecture, Credits 3 (Spring)

VCDE-790 Thesis: Research and Planning
Research is the backbone for any project. This course focuses on the design research and planning stages of a thesis project. Students define a design problem that provides a significant addition to the design field while addressing needs in the local, regional and/or global community. Course content addresses establishing content, planning, scheduling, and research seeking innovative solutions through the process of concept development, ideation, and in-process evaluation. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) Thesis, Credits 3 (Fall)

VCDE-799 Visual Communication Design Independent Study
Visual Communication Design Independent study will allow students to obtain instruction in specialized areas of interest to enhance their individual course of study. Working with a faculty advisor, students will propose a focused curriculum related to their academic and/or future career interests. Visual Communication Design Independent Study students must obtain permission of an instructor to enroll.**NOTE: Student must have a minimum 3.0 GPA.** (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1 - 4 (Fall, Spring)

VCDE-887 Visual Communication Design Part-Time Coop
The Visual Communication Design Co-op will provide real world, on the job experience for students wishing to gain experience at visual communication design. Students will apply and be hired by firms to enhance student’s career readiness. Visual Communication Design co-ops must be approved and sponsored by a faculty advisor. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All Co-ops must fall within an RT term (fall, spring, summer). (This course is restricted to students in the VISCOM-MFA, CMGD-MFA and GRDE-MFA programs.) Co-op, Credits 0 (Fall, Spring, Summer)

VCDE-890 Thesis: Implementation and Evaluation
This course focuses on the physical thesis project. Students work independently on their concept development concluding with the implementation and retrospective evaluation of their chosen design problem. Solution is presented in a public exhibition, complemented by a written articulation of how the theories and methods employed in the project impact the current and future state of design in society. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 6 (Spring)

VCDE-892 Continuation of Thesis Visual Communication Design
The MFA Visual Communication Design Continuation of Thesis course provides student additional semester(s) to complete their thesis research, project, and thesis document. (Prerequisite: VCDE-890 or equivalent course and student standing in the VISCOM-MFA program.) Continuation, Credits 0 (Fall, Spring)

School of Film and Animation

VCDE-601 Graduate Production
A fundamental course in 16mm non-synchronous film and basic digital video production. Filmmaking is presented as a means of interpretation and expression. This course combines technical information, camera technique and editing with a theoretical and practical approach to motion picture continuity. Production is divided into two learning experiences: 16mm (non-sync) format and digital video format. Students furnish film, tape and processing with equipment furnished by the department. (This course is restricted to students in the FILMAN-MFA program.) Lab, Lecture, Credits 3 (Fall)

VCDE-602 Production Processes
This course is an introduction to all aspects of professional film/video narrative production. Students produce short projects while learning basic shooting and crewing procedures, studio protocol, equipment handling and maintenance, and basic sync editing. (Prerequisites: SOFA-601 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture, Studio, Credits 4 (Spring)

SOFA-603 2D Animation I: Fundamentals
This course will introduce graduate students to the concepts and mechanics of movement for animation, focusing on, but not limited to, character based movement. Animation principles and theories on movement and acting will be introduced and applied using hand-drawn methods, which will serve as the foundation for their application in any desired medium. Various styles of animation timing will be examined and students will have the opportunity to develop their own sense of timing and movement. Multi-week exercises will be recorded using standard animation software, and will be reviewed, discussed and open to group critique. (This course is restricted to students in the FILMAN-MFA program.) Lecture, Credits 3 (Fall)

SOFA-604 2D Animation II: Mechanics
This course builds on information gained from foundation animation courses. Multi-week assignments will allow students to fully grasp the production process involved in hand-drawn animation and develop an understanding of different parameters commonly found in animated films, including but not limited to character interaction, emotion and animal movement. Students will have the opportunity to explore various approaches to timing, movement, acting and characterization. Character design and solid drawing skills are highly recommended. (Prerequisites: SOFA-603 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture, Credits 3 (Spring)

SOFA-605 Basic Sound Recording
This course provides specialized knowledge and work in sound to prepare the student to be able to distinguish and evaluate proper sound techniques and productions to encourage the beginning of professional work in the sound industry. Each student records audio and prepares a mixed soundtrack to professional quality standards. (This course is restricted to CIAS Graduate students.) Lecture, Credits 3 (Spring)

SOFA-606 Graduate Directing
An introduction to the arts of directing and acting with an emphasis on script analysis, performance, and blocking. Students direct and act in scenes from professional productions. Scenes are rehearsed outside of class, and then staged and critiqued in class. (This course is restricted to students in the FILMAN-MFA program.) Lecture, Credits 3 (Fall)

SOFA-607 Advanced Directing
Students deepen skills in analyzing scripts and directing actors while adding the breakdown of scenes into shots and the choreography of the camera with actors. Students stage scenes from professional productions in class, and then shoot and edit them outside of class with a focus on creative rather than technical accomplishment. (Prerequisites: SOFA-606 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture, Credits 3 (Spring)

SOFA-608 Dramatic Structure
This course explores the theories of dramatic structure from Aristotle to the present and applies these theories to current and classic dramatic works. The class also explores dramatic script structure as it is used in dramatic works on stage and screen. (This course is restricted to students in the FILMAN-MFA program.) Lecture, Credits 3 (Fall)

SOFA-610 Graduate Seminar
A forum to establish among a diverse student group a common vocabulary for discussing film language and structure, collaborative relationships, and a sense of community, while exploring issues related to scene analysis, production practice and planning, storyboarding, story-telling, visual music, School of Film and Animation policies and professional/business realities. (This course is restricted to students in the FILMAN-MFA program.) Lecture, Credits 2 (Fall)

SOFA-611 History and Aesthetics of Animation
This course will provide a general survey of the development of animated film making around the world from the late 19th century to today. It will be an exploration of the history and aesthetics of Animation with emphasis on the unique characteristics of the form and how those characteristics are used as a means of interpretation and expression. (This course is restricted to CIAS Graduate students.) Lecture, Credits 3 (Spring)

SOFA-613 Graduate Screenwriting I
This course focuses on the forms and techniques of writing for visual media, particularly the short film. Throughout the course, students develop resources for finding stories and concepts that can be turned into films. Students are responsible for writing a short script of their own choosing and for completing several brief written exercises in areas such as personal storytelling, character development, dialogue, and plot. Scripts written in this class can be used as the basis for films produced in other classes. (This course is restricted to students in the FILMAN-MFA program.) Lecture, Credits 3 (Fall)

SOFA-614 Business and Careers in Film
An exploration to all aspects of the business side of professional film/video narrative and commercial production. Students develop a business plan to create their own production company while learning alternative careers in film, basic financial and legal protocol, and mental preparation needed to enter the film business market. (Prerequisites: SOFA-621 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture, Credits 3 (Fall)
The computer has become an integral part of modern animation production. This course will

SOFA-617 Stop Motion Puppet Fundamentals
This course will give graduate students a basic and solid understanding of stop-motion animation. The class covers all aspects of stop-motion in its various forms but will mainly concentrate on stop-motion puppet / character animation. There will be demonstrations on model fabrication, animation techniques and camera / grip techniques. This is an introductory course more in-depth topics, like latex and silicon mold making and intensive postproduction techniques will be introduced but not pursued in depth. (This course is restricted to FILMAN Graduates and post work and will contribute to the team film until the completion of that project. The team members will specialize in certain areas of building, camera work, animation movement and post work. This class builds on the fundamentals that were taught in the Puppet Fundamentals class and advances the student in their understanding of stop motion production. The team members will specialize in certain areas of building, camera work, animation and post work and will contribute to the team film until the completion of that project. The next step for these advanced students upon completion of this class will be to create an MFA thesis film. (Prerequisites: SOFA-617 or equivalent course and graduate student standing in FILMAN-MFA.) Lab, Lecture, Credits 3 (Spring)

SOFA-623 Stop Motion Master Class
This course will introduce stop motion MFA students to more advanced techniques of single frame production. The class will be divided into teams that will execute a finished short film complete with mixed track and finished titles and credits. (Prerequisites: SOFA-601 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture, Credits 3 (Spring)

SOFA-624 Tradigital Animation
The computer has become an integral part of modern animation production. This course will introduce students to the application of computer technology to animation to aid them in incorporating it into their personal skill sets. The focus will be on adapting traditional techniques to the digital production environment. The student will work with professional level animation software using both raster and vector graphics to produce several short exercises adapted from traditional techniques that will develop the skills needed to efficiently and effectively use two-dimensional digital tools in their own work. (This course is restricted to students in the FILMAN-MFA program.) Lab, Lecture, Credits 3 (Fall)

SOFA-625 Animated Acting Principles
This course will give graduate animation students an opportunity to explore a visual language of acting and posing that will help their storytelling abilities. Acting, timing and pacing are critical elements to any successful character animated film. Identifying and building a library of expressions, poses, and movement for emotional and visual expression is the goal for each student. Students will study reference material from successful silent and animated films. They will also create their own reference material through acting and filming themselves and other students. The visual references will be scrutinized on a frame-by-frame basis for a deeper understanding of this visual language. The course will include demonstrations by practicing actors and animators. Graduates will produce some animated studies related to the acting principles. (Prerequisites: SOFA-630 or equivalent course and graduate student standing in FILMAN-MFA.SOFA-630 & FILMAN-MFA) Lecture, Credits 3 (Spring)

SOFA-626 Writing the Short Film
This is a course in writing for short films. The course includes an exploration of the short film genre and how that differs from other narrative forms. In the course, students complete exercises to improve their ability to write scenes and develop characters. To conclude the course, students write a short script appropriate for filming in one of the production courses. (Prerequisites: SOFA-613 or equivalent course and graduate student standing in FILMAN-MFA.SOFA-613 & FILMAN-MFA) Lecture, Credits 3 (Fall)

SOFA-627 Pre-Production for Animators
Students collect and produce short film ideas and learn to express them in a variety of methods. Short film scripts will be written in a workshop setting and shared with class in critiques. Students will learn how to create digital storyboards and read digital sound. Students will make animation bar sheets for sound/image relationships and timings and exposure sheet design. Students will also work with storyboards scanned into the computer and manipulated in time with sound to create an animate as another tool for initializing animation production. (This course is restricted to students in the FILMAN-MFA program.) Lecture, Credits 3 (Spring)

SOFA-628 Animation Writing and Visual Storytelling
This course is an in-depth examination of structural elements of both the written and visual aspects of the animated film and the pre-production process, specifically. Particular attention is given to the application of materials to a short film format and the layout of movements and visual composition via editing into storyboards. Students will create and submit various written scripts culminating in a final production script for development into working, formatted animation storyboards. Story elements will be created and shown by developing elements of the script, as well as visual treatments by utilizing subtext and thematic understanding. (Prerequisites: SOFA-627 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture, Credits 3 (Spring)

SOFA-630 Animation Film Language
This course is intended to introduce the student to the theory and practice of making animated films. Lectures, readings and classroom discussions will emphasize the history, theory and practice of animated filmmaking with extensive film screenings to illustrate various techniques and related aesthetics and ideas. A contrast and comparison of animation and live action film theory will elucidate the unique aesthetic and expressive properties of the animated film. (This course is restricted to students in the FILMAN-MFA program.) Lecture, Credits 2 (Fall)

SOFA-635 Acting for Film
A course in basic acting technique with an emphasis on the requirements of film production. Students are introduced to various approaches to acting through exercises and by performing in scenes from professional productions. Scenes are rehearsed outside of class, and then staged and critiqued during class time. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring)

SOFA-638 Complete 3D Character Creation
This course covers a broad range of three-dimensional animation related topics in a detail-oriented manner. The various topics will be anchored in the design and development of an original 3D character. Topics covered will include, but not be limited to, modeling, rigging, texturing, and lighting. Students will design and build a 3D character of their own design. Using a variety of 3D techniques, students will create a fully articulate character rig and produce a short animation demonstrating its functionality, as well as their proficiency in techniques such as lighting, texturing, and rendering. (Prerequisites: SOFA-695 or equivalent course and graduate student standing in FILMAN-MFA.) Lab, Lecture, Credits 3 (Fall, Spring)

SOFA-641 Advanced Sound Recording
This course continues the work from SOFA-605 Basic Sound Recording to include audio synchronization or locked to picture and the use of Foley andADR production techniques. Students develop workflow approaches for complex multi-track mixing and signal manipulation. Each student prepares a mixed track to professional quality standards and manages sound and video files between various hardware and software platforms. (Prerequisites: SOFA-605 or equivalent course and graduate student standing in FILMAN-MFA.) Lab/Lecture, Credits 3 (Spring)
SOFA-642 History and Aesthetics: Animation Stories
This course provides an in-depth study of a specific movement or individual(s) that has made a major contribution to the animated film art form. Films will be viewed and discussed in the context of the specific times and places in which they were made. Emphasis is on determining the unique characteristics of the animation medium and how those characteristics have been used as a means of interpretation and expression from historical, cultural and individual perspectives. (This course is restricted to CIAS Graduate students.) Lecture, Credits 3 (Fall)

SOFA-644 Cinematic Compositing
Students will learn digital compositing using rotoscoping, image tracking, alpha channels and transparency. Composites may be accomplished through green screen shooting, transfer modes, masks, and/or traveling mattes. Students will shoot their own footage to combine with their effects to create the final image. Node based compositing will be addressed as well. (Prerequisites: SOFA-602 or SOFA-624) and graduate student standing in FILMAN-MFA.) Lab, Lecture, Credits 3 (Spring)

SOFA-652 Alternate Frame by Frame
This course will give all students a chance to explore three different approaches to stop-motion animation. The class will study and experiment with pixilation, time-lapse and relief animation with a “down-shooter.” These techniques will expand the student’s knowledge of traditional or character animation and present an alternative means of expression. Students can explore character or experimental approaches to animation with these non-traditional approaches to single frame animation. The class will study existing work with these techniques, analyze and discuss them with the instructor and then produce several examples of their own after instruction for each approach. There will be a final project in the technique of the student’s choice. (Prerequisites: SOFA-603 or SOFA-617 or SOFA-615 or SOFA-606 or equivalent course and student standing in FILMAN-MFA.) Lecture 3, Credits 3 (Spring)

SOFA-662 International Film History
This course examines selected, varying film topics in a wider socio-historical context. Seminar themes change each year but may include topics as post-war German film, films of the Holocaust, Japanese film, Surrealism and Magic Realist film, Soviet film, Native Americans on film, etc. Students are expected to participate actively in the course discussions. (This course is restricted to CIAS Graduate students.) Lecture, Credits 3 (Fall, Spring)

SOFA-663 Writing the Feature
This is an exploration of the feature film form. Students propose ideas for a feature length film and in consultation with the instructor and other students, write a detailed step outline and a substantial portion of the first draft. (Prerequisites: SOFA-626 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture, Credits 3 (Fall)

SOFA-664 Writing the Series
This course is an introduction to all forms of series writing for television and the Internet. Students will choose to write either a one-hour pilot for a dramatic series, or a half-hour pilot and an additional episode for a single-camera comedy series. All students will develop and write a series “bible,” a thorough description of all the characters and the world in which the series takes place as well as how the series may develop with future plotlines. (Prerequisites: SOFA-626 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture 3, Credits 3 (Spring)

SOFA-665 Creative Research Workshop
A research and/or production opportunity for advanced students with extensive prior experience in the field of animation or live action filmmaking to work on a special project independently or collaboratively under the supervision of a faculty advisor. Enrollment in this course is by application only and with permission of a faculty advisor. (This course is restricted to students in the FILMAN-MFA program.) Lecture, Credits 3 - 6 (Fall, Spring)

SOFA-667 Acting for Film and Video II
This course builds on the basic acting class with the additional focus of using external observation to determine appropriate behavior. Class meetings are organized around the presentation of scenes prepared by student actors and directors. The class is taught in conjunction with Advanced Directing. (This course is restricted to students in the FILMAN-MFA program.) Lecture, Credits 3 (Spring)

SOFA-668 Alternate Traditional Animation Techniques
This course is intended to introduce the student to the variety of traditional techniques for making animated films directly under the camera. Lectures, readings and hands-on experiences will explore the practice of optically recorded animated filmmaking. Extensive film screen-ings will illustrate various techniques and their related aesthetics. Students will create several short film projects using the techniques they have learned. (This course is restricted to CIAS Graduate students.) Lab, Lecture, Credits 3 (Spring)

SOFA-670 30 Second Commercial Production
An introduction to the world of producing television commercials. Students learn the workflow between advertising agencies, their clients and production companies. They also execute the production of a television commercial from conception to editorial. (Prerequisites: SOFA-602 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture, Credits 3 (Spring)

SOFA-671 Advanced Production Immersion
This workshop provides students with the opportunity to learn more about a particular area of production — editing, cinematography, lighting, sound, etc. — with an industry professional. Different topics may be taken in the same semester. Topics may only be taken once. (Prerequisites: SOFA-601 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture 3, Credits 3 (Fall, Spring)

SOFA-672 Mixing and Sound Design
This course continues the work done in SOFA-641 Advanced Sound Recording by mixing multitrack sessions with video to post-produce different projects to professional standards. Students learn how to listen and develop a trained ear while understanding room equalization and use of effects and digital signal routing. Sessions can include documentaries, dialog and musical productions. Students also create templates and develop editing/mixing techniques to balance creativity and time constraints of a typical project. (Prerequisites: SOFA-641 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture, Credits 3 (Spring)

SOFA-673 Camera Choreography
An exploration of multiple camera movement techniques utilized in obtaining proper coverage of a scene. Students participate in weekly hands-on exercises to develop and improve cinematic storytelling through various camera moves. (This course is restricted to students in the FILMAN-MFA program.) Lecture, Credits 3 (Spring)

SOFA-675 3D Lighting and Texturing
Students will learn to use lighting in three-dimensional software. Projects include modeling, texturing, and lighting of objects, characters and spaces. Students will match photographic images and three-dimensional objects in lighting, blur, color, contrast and perspective. Students will imitate photorealism by combining shadows, textures, direct lighting, indirect lighting, reflections, and refractions. Students will use a variety of rendering programs to create composites. (Prerequisites: SOFA-615 or equivalent course and graduate student standing in FILMAN-MFA.) Lab, Lecture, Credits 3 (Spring)

SOFA-676 Cinematography and Lighting
In this course students explore the world of cinematography and lighting and how they relate to each other. Students participate in weekly hands-on exercises to develop and improve cinematic storytelling through composition, framing and lighting techniques. (Prerequisites: SOFA-602 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture/ Lab, Credits 3 (Fall)

SOFA-681 Particle Effects and Dynamics
This course gives students the skills to insert three-dimensional computer special effects into animation and live action footage. Students explore three-dimensional computer particle animation and dynamics simulation. Students will create short animations to simulate fire, rain, smoke, lighting, water and other dynamics-based collisions. (Prerequisites: SOFA-615 or equivalent course and graduate student standing in FILMAN-MFA.) Lab, Lecture, Credits 3 (Fall)

SOFA-682 Underwater Cinematography
This course is designed to prepare students to professionally complete cinematography assignments in an underwater environment. To accomplish this, the student will complete basic scuba diving training and achieve scuba diving certification. The student will become familiar with underwater video camera housings and accessories and basic underwater shooting techniques. A facility fee covers all equipment, off campus facility use, texts and insurance. (Prerequisites: SOFA-601 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture/Lab, Credits 3 (Fall)

SOFA-683 Advanced Editing
This course is designed to teach students the professional workflow of editing digital film and video files. Students learn the technical craft as well as the aesthetic choices that editors make. Students practice the editing of all genres by editing short fiction, documentary, and experimental projects. Students will explore and learn advanced tools in Final Cut Pro editing software while editing short projects and tutorials. Areas of study include learning a cinema file database, media management, color correction, visual and time based effects, sound processing and track building, multi-camera editing, and titling and graphics. In the second half of the semester, students will learn the basic operation system of AVID editing software and complete three short projects using AVID software. (Prerequisites: SOFA-601 or equivalent course and graduate student standing in FILMAN-MFA.) Lab, Lecture/Lab, Credits 3 (Spring)
SOFA-695 Advanced 3D Animation
This course pushes character animation to a new level with drama, emotion, and speech. Topics will include facial expressions and scenes with multiple characters interacting. Professional animation software will be used. By the end of the course, students will be able to create advanced biped character animation with dialogue and emotion. (Prerequisites: SOFA-615 or equivalent course and graduate student standing in FILMAN-MFA.) Lab, Lecture, Credits 3 (Spring)

SOFA-696 Fusion Team Production
Students will learn to combine various media including live action, two dimensional animation, and/or three dimensional animation. Projects include camera matching and compositing. Students will work in a team with lighting, color, contrast, and perspective across multiple media. Students will have characters and objects interacting across different media. (Prerequisites: SOFA-604 or SOFA-602 or equivalent course and student standing in FILMAN-MFA.) Lecture, Credits 3 (Spring)

SOFA-699 Film and Animation Co-op
The SOFA Graduate Co-op will provide students with the option to work in the Film Industry and get paid. There is no academic credit awarded for this course. The opportunity must demand a minimum of 20 hours per week. Students may apply for co-op employment to businesses based on the availability of positions and business job needs. Permission from the SOFA Graduate Program Director required. (Enrollment in this course requires permission from the department offering the course.) Co-op, Credits 0 (Fall, Spring, Summer)

SOFA-704 2D Animation III: Camera and Sequence
This course builds on information gained from previous animation courses as well as concepts of visual storytelling and sequence construction. Students will create multiple characters, environments and a "story" to animate through shot selection, building on action and performance. Students will use and utilize a moving camera, pans, character interaction and the connectivity of four shots that show a cohesive idea as well as advanced animation skills. Considerable drawing and character design skills are highly recommended. (Prerequisites: SOFA-604 and SOFA-628 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture, Credits 3 (Fall)

SOFA-721 Fall Film
This course allows the second year graduate student in Production or Screenwriting an opportunity to complete their second major production in the program. They must decide on a concept, develop a treatment, write a script or research a non-fiction subject and produce the film complete with mixed track and finished titles and credits. (Prerequisites: SOFA-604 or equivalent course and graduate course standing in FILMAN-MFA.) Lecture, Credits 3 (Fall)

SOFA-748 Concept and Character Design
This course will introduce students to the basics of design as applied to characters and environment for animated productions. Students will create and develop a ‘cast’ of characters for an imagined property, focusing on group dynamics, visual appeal and personality development. Line, color, texture, shape, form and story will be referenced when developing characters. Students will institute a process of visual development through a variety of exercises, working toward a final, finished group of characters. Strong attention and development will be paid to color, composition, and atmosphere. Projects require a high level of drawing skill and knowledge of perspective, as well as story and character development. Projects will utilize hand drawn, digital painting, live action and subjective techniques. A variety of exercises will cover tone, mood, deep and shallow space, multi-plane movement, and natural and imagined spaces. (Prerequisites: SOFA-628 or equivalent course and graduate student standing in FILMAN-MFA.) Lecture, Studio 3, Credits 3 (Spring)

SOFA-790 Research and Thesis I
Students work independently according to their approved timeline on their thesis project. They must meet on a regular basis with their Committee Chair and at least twice with their full committee during the semester. This is the first of two courses designed to advance a student towards completion of their thesis. Once the Thesis committee determines that the candidate has completed 50% or more of the project the student should register for SOFA-890 Research and Thesis. (Prerequisites: SOFA-780 or equivalent course and graduate student standing in FILMAN-MFA.) Thesis, Credits 3 (Fall)

SOFA-799 Research and Thesis II
Students complete their thesis projects. Students are supported in the development of a research thesis as well as any other required materials. The thesis must be developed in consultation with the student’s committee. The thesis must be approved by the College of Imaging Arts and Sciences Graduate Program Director. (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1 - 4 (Fall, Spring, Summer)
PPRT-601 Materials and Processes in Printing
This course offers a survey of the materials and processes used in print reproduction. Students will learn the basic theory of image reproduction embodied in the available analog and digital printing processes, and learn to identify the process origins of print samples. Additionally, students will learn the chemical and physical properties associated with consumables in order to obtain an understanding necessary to make informed decisions about use and application. (PRINTMED-MS) Lecture 3, Credits 3 (Fall)

PPRT-602 Tone and Color Analysis
This course covers fundamentals of color measurement, color management system, and color reproduction technology for color matching and color image reproduction. Emphases are placed on CIE colorimetry, device calibration and characterization, and color management systems. (PRINTMED-MS) Lab 3, Lecture 2, Credits 3 (Fall)

PPRT-603 Operations Management in the Graphic Arts
An in-depth study of the factors affecting the efficiencies and effectiveness of print media organizations and ultimately their profitability. Includes consideration of both internal factors, such as quality level goals, training, scheduling, plant layout, and financial management, and external factors, such as environmental and legal issues and safety enforcement. (PRINTMED-MS) Lecture 3, Lecture 2, Credits 3 (Fall)

PPRT-641 Digital Printing and Publishing
This course provides students with the opportunity to learn the concepts and applications of digital printing. The course examines the technology of several major digital print engines and compares digital printing to conventional print processes. The economics and application of specific digital printing processes are examined from a workflow perspective. (PRINTMED-MS) Lab 3, Lecture 2, Credits 3 (Spring)

PPRT-661 Dynamic Communication Processes
This course focuses on the integration of content from various media sources to create customized dynamic communications. Topics include the process of understanding and utilizing databases, digital assets, and tools to create and distribute customized documents through the web and in print. Lecture 3, Credits 3 (Fall)

PPRT-666 Typography Research
The course builds on fundamentals and skills taught in introductory and advanced typography courses by developing methods of investigation, research, and analysis, with the goal of enabling students to conduct independent research. Students will choose individual typographic topics to research (e.g., technology, psychology, history, aesthetics, imaging, writing systems, culture, and society). Course lectures will survey these topics. Students each give presentations on their topics and prepare a written report. The course emphasizes individual initiative and seminar participation. (PRINTMED-MS) Lecture 3, Credits 3 (Spring)

PPRT-671 Advanced Digital Asset Management
In this course students will research the current and future trends associated with content management as well as digital asset management. Students will understand what metadata is, the standards that are frequently applied, the creation of custom metadata, and the various uses of metadata in the automation of asset creation, storage, and retrieval. Lecture 3, Credits 3 (Fall)

PPRT-673 Transmedia Publishing and Storytelling
Transmedia Publishing is a form of multimedia communications that tells stories from a database of media assets. It differs from conventional publishing in that the reader dynamically participates in shaping the story and the story is adapted to the channel used to distribute it. Students create stories through the application of the theoretical principles, methods and tools employed in transmedia publishing and storytelling. Lecture 3, Credits 3 (Spring)

PPRT-688 Package Printing
This course introduces students to the package printing industry. Printing processes, materials, production workflows and quality control systems used in package printing will be introduced. Students will take several packages from creation to final printed product. Lab 3, Lecture 2, Credits 3 (Spring)

PPRT-699 Print Media Grad Co-op
The co-op will provide students with the opportunity to work in the graphic communication field. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All Co-ops must fall within an RIT term (fall, spring, summer). (Enrollment in this course requires permission from the department offering the course.) Co-op, Credits 0 (Fall, Spring, Summer)

PPRT-703 Cross Media Workflow
This course is designed to expose students to all the elements needed to master a cross media publishing project. Students will learn concepts and laws around copyright as it applies to cross media publishing. Concepts and tools necessary for the implementation of a cross media workflow will be discussed and reinforced with hands-on exercises. Additionally, ways companies create and utilize cross media workflows will be studied. Emerging industry and ISO standards as well as best practices for each of the fields discussed in the course will be presented. (PRINTMED-MS) Lecture 3, Credits 3 (Spring)

PPRT-704 Research Methods and Trends in Graphic Media
This course provides a foundation for conducting scientific research in the graphic communications industry. Students will learn the scientific method, how to generate a hypothesis or research question, conduct secondary research, select the best research design to answer the research questions, and how to analyze basic survey data. The course will also introduce students to the current issues in the industry in preparation for them to identify a thesis or capstone project problem. (PRINTMED-MS) Lecture 3, Credits 3 (Fall)
PPRT-721 Implementing Media Business Change
This course provides the knowledge required to improve a graphic communication business. Students gain an understanding of the business assessment process and the knowledge to apply analysis and decision-making skills to engage in implementing change in the Graphic Communications Industry. Students learn how to evaluate a firm’s economic, operational, and market positions and to apply practical solutions to improve business practices, operations, resource allocation, and services model. Lecture 3, Credits 3 (Fall)

PPRT-731 Digital Content Management
This course addresses digital content management through the exploration of media organization and structure. Students learn how to use the structure of digital content to deploy and style for various publishing solutions. This course will focus on understanding and analyzing digital content solutions as they apply in various business models. Lecture/Lab 4, Credits 3 (Fall)

PPRT-745 Typography Research
The course builds on fundamentals and skills taught in introductory and advanced typography courses by developing methods of investigation, research, and analysis, with the goal of enabling students to conduct independent research. Students choose individual typographic topics to research (e.g., technology, psychology, history, aesthetics, imaging, writing systems, culture, and society). Students each give presentations on their topics and prepare a written report. The course emphasizes individual initiative and seminar participation. Enrollment in this course requires permission from the department offering the course. Lecture, Credits 3 (Spring)

PPRT-746 Capstone I
This course will acquaint students with the resources of Rochester Institute of Technology necessary for the completion of a meaningful capstone project in a one-year timeframe. In addition, students will be introduced to the project management skills required to successfully propose a capstone project that will be meaningful, relevant and feasible. Lecture 3, Credits 3 (Fall)

PPRT-747 Capstone II
This course will take students from their capstone proposal through the completion of a capstone project. Building on the student work in Capstone I, students will report on their capstone progress and be led by faculty through a meaningful and significant capstone in their relevant domain. In addition, students will be prepared for their chosen post-Masters endeavors, including the implementation and potential publishing of their capstone project. Prerequisites: PPRT-746 or equivalent course. Lecture, Credits 3 (Spring)

PPRT-763 Applied Data Analytics
This course prepares a student to apply data analytics to understand the unmet and undefined content needs of a target audience. Students will learn secure and repeatable data analysis practices in a closed-loop cross media communications value chain. (Note: consent of Instructor) This course requires permission of the Instructor to enroll. Lecture 3, Credits 3 (Spring)

PPRT-790 Thesis
To conduct research on a topic relevant to the graphic arts industry. Topic must be approved by a committee comprising graduate faculty and an advisor. Enrollment in this course requires permission from the department offering the course. Thesis, Credits 6 (Fall)

PPRT-799 Independent Study
The student will work with a faculty adviser to create a series of readings, writings, or original research that addresses a key concern in the field of graphic communications. **NOTE: Student must have a minimum 3.0 GPA.** Enrollment in this course requires permission from the department offering the course. Independent Study, Credits 1 - 6 (Fall, Spring, Summer)

PPRT-892 Continuation of Thesis Print Media
This course allows the student to continue thesis research on a topic relevant to the graphic arts industry. Topic must be approved by a committee compromising graduate faculty and an advisor. (Prerequisites: PPRT-790 or equivalent course and student standing in PRNTMED-MS.) Continuation, Credits 0 (Fall, Spring)

School of Photographic Arts and Sciences

PHGR-631 New York City Grad Photography Field Trip
Fine art photography students in this class will have the unique opportunity to participate in a one-week intensive workshop that travels to New York City, the center of the photography industry. During the field trip, accompanying lectures and studio/museum/gallery visits students will gain an immersive exposure to the field of fine art and applied photography and related industries in New York City. Students will meet with a variety of photographers, art gallery directors, museum personnel, studio artists, assistants, and RIT alumni. Photography studios, magazines, galleries, and photo/art museums and universities will be visited during the one-week field trip. (Prerequisites: PHGR-703 or equivalent course.) Lecture 1, Credits 3 (Spring)

PHGR-640 Gallery Management for Artists
This graduate seminar course will introduce students to practices and procedures in gallery management. Exploration and inquiry into all aspects of gallery administration and exhibition implementation will be covered. Emphasis is placed on understanding the role of the curator and curatorial practice as well as becoming aware of current issues in gallery and museum management. Skills to be developed and explored include: preparing gallery space and artwork for installation; preparing exhibition text and support materials; writing press releases, reviews and artist statements; developing fund raising strategies and researching funding sources; writing grant applications; gallery maintenance; caring for artwork, and laying out a show; utilizing archives and collections; and understanding the aesthetics of showing artwork in a gallery, including sequencing, curatorial interpretations, and space arrangement. Hands-on experience is achieved with exhibitions on campus and off site gallery related events and experiences. Blended learning will support classroom instruction, in addition to lectures and other forms of media. (This course is restricted to CIAA Graduate students.) Lecture 3, Credits 3 (Fall, Summer)

PHGR-656 Moving Media I
Students will work with digital video recording and electronic imagery to create new work that expands the disciplines of photography and video. Projects will involve creating experimental narratives, conceptual constructions, and performance pieces. Students will work with traditional photographic processes, electronic media, web resources, editing software, and projection technologies to create and display their work. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lab 3, Lecture 2, Credits 3 (Fall)

PHGR-657 Moving Media II
This course uses foundational skills developed in Moving Media I to work with time-based imagery projects in order to advance visual language and technical skills. Students learn to record sound with off-camera microphones and sound recorders. Students study historic and contemporary media artists, and analyze various strategies used to convey conceptual ideas. Students will design a series of independent projects and produce a final project for presentation in the Media Café. (Prerequisites: PHGR-656 or equivalent course.) Lab 3, Lecture 2, Credits 3 (Spring)

PHGR-665 Color Photography Graduate Seminar
This course represents a creative exploration of technology when producing traditional film color photography and digital imaging. Students will use film and progress through digital. Effective scanning techniques, proper color management and procedures for digital image editing and manipulation will be explored. Various methods of printing and output will be discussed and experienced through assignments. Students will conceive and design their own photographic project and produce a collection of prints. Students will also write a research paper pertinent to their own artistic exploration. (IMGART-MFA) Lab 3, Lecture 2, Credits 3 (Fall, Spring)

PHGR-698 Photography Internship
The photography internship will provide students with the option to work in the photographic field. Students may apply for internships to businesses based on the availability of positions and business job needs. Students must obtain permission of an instructor and complete the Internship Permission Form to enroll. (IMGART-MFA) INT, Credits 1 - 3 (Fall, Spring, Summer)

PHGR-699 Cooperative Education Experience
Co-ops are an opportunity for students to gain experience in their field. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All Co-ops must fall within an RIT term (fall, spring, summer). The RIT Office of Cooperative Education and Career Services assist students in identifying co-op placements and opportunities. (IMGART-MFA) Co-op, Credits 0 (Fall, Spring, Summer)
PHGR-702 History of Aesthetics of Photography II
This spring semester course focuses on conceptual developments within the significant themes of the multiple, intersecting histories and aesthetic practices of photography. Integrating fine art, documentary, photojournalism, and commercial and editorial photography, we will consider photographic genres and movements within a broader cultural framework. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Spring)

PHGR-703 Imaging Core I
The principle critique class for students in the MFA Imaging Arts program. Each student will establish a working methodology, which allows for experimentation with attention to process. Students are expected to undertake a conceptually creative and intellectually challenging investigation into their own work. Through a critical engagement with peers, each student develops a body of new work and an artist's statement. (IMGART-MFA) Lecture, Credits 3 (Fall)

PHGR-704 Imaging Core II
This course is the second in the sequence of principle critique classes for students in the MFA Imaging Arts program. Having established a working methodology in Imaging Core I, students will continue to experiment and consolidate a significant body of work through a critical engagement with peers. The focus of the course will lead to half-candidacy conducted through a formal MFA faculty review of the work. (Prerequisite: PHGR-703 or equivalent course.) Lecture, Credits 3 (Spring)

PHGR-711 Graduate Seminar
This course is the primary community-building experience for new graduate students introducing them to the MFA program at RIT. Students will hone their skills in image interpretation, critical analysis and scholarly writing as applied to visual artwork. While also learning about the multiple research facilities and capabilities of the Institute and the larger region (George Eastman House, Visual Studies Workshop, etc.) (IMGART-MFA) Lecture, Credits 3 (Fall)

PHGR-721 Research Core I
This course will outline the policies and procedures required for the MFA thesis (thesis exhibition, thesis defense and thesis publication) and provide students with research tools and resources to begin the development of the thesis publication and defense. Class presentations will include methods of scholarly writing, research as well as editing and sequencing procedures for the creation of the capstone thesis defense and publication work. Lecture, Credits 3 (Fall)

PHGR-722 Contemporary Issues
A study of current issues relevant to photo-based fine art and related media, how they relate to broader historical/cultural issues and how they might suggest future directions. Emphasis is placed on the integration of critical theoretical discourses and studio practice. **NOTE: This course can be repeated for credit.** (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall, Spring)

PHGR-723 Research Core II
Research Core II is the second term of a year-long required course which supports the SPAS MFA student in the completion of the thesis publication and thesis defense. Supported by the research tools and resources outlined in Research Core, students will conduct practice defenses and write, edit, and fabricate a thesis publication to complete their graduate experience. (Prerequisites: PHGR-721 or equivalent course and student standing in IMGART-MFA.) Lecture, Credits 3 (Fall, Spring)

PHGR-757 Workflow for Image Makers
This course addresses the vital issue of digital imaging workflow within a fine art discipline. In combination with this practical approach, this course also places fine art digital image-making within the historical context of art, photography, and culture, in particular its relationship to photomechanical processes and new media. Students will learn digital imaging from conceptualization to capture to output with consideration of its specific aesthetic language. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Spring)

PHGR-767 Beyond the Family Album
This course balances the production of original artwork with primary and secondary research within a seminar format. The narrative of the family photographic album is a core subject of investigation. The concept of an album and its content move beyond the conventions of a book form to embrace new technologies and installation. Visual art projects addressing the representation of family life in the public and private spheres and interdisciplinary critical readings form the underpinnings of research against which written and visual work will be produced. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Spring)

PHGR-776 Artist as Teacher
This graduate seminar course will introduce students to practices and processes used for teaching art in higher education. The course will focus on the development of teaching methods and introduce graduate students to the scholarship of teaching. Exploration and inquiry into a range of perspectives on pedagogical practices, curriculum development, and the assessment of learning from the perspective of the visual arts will be covered. The course components will include: readings, research, discussions, project assignments, lectures, and peer presentations. The final outcome will be a teaching portfolio including a teaching philosophy, course proposals, a detailed syllabus, sample class assignments, and evaluation and assessment guides. Blended learning will support classroom instruction, in addition to lectures and other forms of media. (This course is restricted to CIAS Graduate students.) Lecture 3, Credits 3 (Fall, Spring)

PHGR-799 Imaging Arts Graduate Independent Study
Imaging Arts Graduate Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty advisor, should propose a course of study or project with clearly defined goals and outcomes. Students must obtain permission of an instructor and complete the Independent Study Permission Form to enroll. **NOTE: Student must have a minimum 3.0 GPA. ** (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1 - 4 (Fall, Spring, Summer)

PHGR-887 Imaging Arts MFA Part-Time Coop
Co-ops are an opportunity for students to gain experience in their field. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All Co-ops must fall within an RIT term (Fall, Spring, Summer). The RIT Office of Cooperative Education and Career Services assist students in identifying co-op placements and opportunities. Co-op, Credits 0 (Fall, Spring, Summer)

PHGR-890 Thesis
The thesis work produced within this course represents the capstone project of the MFA degree in Imaging Arts. The completion of the thesis exhibition in its entirety, artwork, artist's statements, extended statements for Thesis Publication and installation of exhibition, are the main focus of this course. Thesis 6, Credits 6 (Fall, Spring)

PHGR-892 Continuation of Thesis Imaging Arts
The imaging arts continuation of thesis course provides students additional semester or semesters to complete their thesis research, project, and thesis document. (Prerequisite: PHGR-890 or equivalent course and student standing in the IMGART-MFA program.) Continuation, Credits 0 (Fall, Spring)
COMM-701 History of Media Technologies
An introduction to the history of media technologies including print, telephone, radio and television broadcasting, and digital media. The course will also cover the inventors, landmark events, regulations, and uses of communication media along with their effects on and relationships with people and culture. Lecture, Credits 3 (Fall)

COMM-702 Communication Theories
This course focuses on theories of communication as they relate to mass media and other forms of human interaction. Theories based in both the humanities and in the social sciences that explain or predict the effects of interaction and communication technology on audiences will be examined. (COMMTCCH-MS) Lecture, Credits 3 (Fall)

COMM-703 Research Methods in Communication
An introduction to and overview of the methods and ethics of scientific, scholarly communication research including quantitative and qualitative approaches. The course focuses on methods of locating, critically analyzing and conducting communication research, and leads to the development of a research proposal suitable for a thesis or project. (Prerequisites: COMM-702 or equivalent course.) Lecture, Credits 3 (Fall)

COMM-704 Media Law and Ethics
This course examines major principles and trends in communication law. The course analyzes a broad range of issues related to the First Amendment, intellectual property, and media regulation. Special attention is paid to discussing the major ethical perspectives and issues surrounding contemporary communication behavior. Lecture, Credits 3 (Spring)

COMM-705 Technology-Mediated Communication
An inquiry into interactive media and how they exert a powerful influence on communicative practices and society. Positioned at the intersection of technology, identity, and culture, interactive media are altering the ways in which people communicate in a wide range of contexts, including education, marketing, civic discourse, politics and popular culture. Applying theories about the relationship between communication technology and culture, this course will explore the current and potential future impact of interactive electronic communication and the social changes that are occurring. Lecture, Credits 3 (Spring)

COMM-706 Crafting the Message
This course will focus on the creation of written and visual messages appropriate to a targeted audience and specific medium including print, broadcast, interactive, digital and online technologies. Case studies of both effective and unsuccessful messages from, for example, advertising, public service, education, and entertainment will be examined. Students will create and execute a variety of messages using different writing styles with images that are directed toward specific target audiences. Lecture, Credits 3 (Spring)

COMM-707 International Media
Evaluation of media technology use in the international setting and in various countries and regions of the world. Major theories about media, current trends in media, journalism practices, and governmental challenges and restrictions are considered. Special attention is paid to the uses and effects of media technologies within various countries, focusing on global implications of the Internet and digital technologies on international cooperation, trade, and culture. Lecture, Credits 3 (Spring, Summer)

COMM-708 Communication Education
An analysis of and practicum in teaching communication in higher education. Students explore teaching and learning styles, the role of technology in higher education, and teaching assessment methods. Students create teaching resources and gain teaching experience in a college classroom. Lecture, Credits 3 (Spring)

COMM-709 Online Advertising
A review of the theory and practice of interactive advertising. Topics include digital interactive media used for advertising purposes, interactive advertising theories and models, and the strategies and tactics for developing effective ad campaigns using interactive media, including the Internet, virtual communities, video games and mobile phones. (COMMTCCH-MS) Lecture, Credits 3 (Spring)

COMM-710 Visual Communication
This course explores visual communication, the process through which individuals -- in relationships, organizations, and societies -- create and interpret visual messages. A variety of theories from the disciplines of art history, psychology, communication theory, and graphic design will be discussed to develop methods for analyzing mediated messages. Students analyze visual messages from the following media: print, video, film and the Internet. (COMMTCCH-MS) Lecture, Credits 3 (Fall)

COMM-711 Persuasion in a Digital Age
Digital communication technologies blur the lines of distinction between mass persuaders, various publics, personal networks, and individuals. This course combines traditional theories and research in media, rhetoric, and persuasion within the context of new and dynamic channels of communication. This course will investigate the prevalence of persuasive communication in various facets of our society with particular attention to the impact of digital communication channels on the persuasion process. Lecture, Credits 3 (Spring)

COMM-713 Classic Media
Required of students without an undergraduate degree in communication. To introduce students to a broad range of important texts. Students will gain an understanding of how theory and research developed in the study of mass media and communication. The course is historical but focuses on the literature and media of the twentieth century. Key research studies and media productions are analyzed. Students learn to write in American Psychological Association style and conduct secondary research. (COMMTCCH-MS) Lecture, Credits 3 (Fall)

COMM-789 Special Topics Communication
An in-depth examination of a selected aspect of the communication discipline (e.g. strategic communication, technical communication, visual communication, technology-mediated communication, advertising, public relations, journalism). Special Topics in Communication can be taken multiple times, provided the topic being studies has changed. (Prerequisite: varies by topic) Lecture, Credits 3 (Fall, Spring, Summer)

COMM-799 Independent Study in Communication
A guided study culminating in a research project that allows students to pursue a subject independently with faculty guidance. Focuses on designing, conducting and completing an independent study project. Independent Study, Credits 1 - 3 (Fall, Spring, Summer)

COMM-800 Communication Thesis/Project
A guided research project that focuses on designing, conducting and completing a research project. The project culminates in a public presentation and defense. Thesis, Credits 1 - 6 (Fall, Spring, Summer)

COMM-890 Continuation of Thesis/Project
A guided research study culminating in an original, systematic, and scholarly study of a significant communication problem. Focuses on designing, conducting and completing an independent research project. The progress of each project is publicly defended. Continuation, Credits 0 (Fall, Spring, Summer)

COMM-999 Co-op
One semester of work experience in a professional setting related to the communication major. Co-op, Credits 0 (Fall, Spring, Summer)

Criminal Justice
CRIM-700 Pro-Seminar in Criminal Justice Theory
In this pro-seminar, students examine the theoretical foundation of criminal justice. This course integrates studies of criminal justice systems, enforcement organizations, judicial decision-making, courtroom communities and correctional systems by focusing on the study of governmental social control premised on punishment or blameworthiness. It examines the underlying causes and patterns of official responses to behavior that may be labeled criminal, and the structures, policies and practices of criminal justice. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall)
CRIM-701 Statistics
The purpose of this course is to provide students with training in quantitative analysis of social science data. Students will develop a conceptual understanding of techniques, the ability to recognize the appropriate selection of techniques, and the ability to use those statistical measures and interpret their results. Students will gain experience with inferential statistics through the level of commonly used multivariate analyses. The prerequisite for this course will be a strong undergraduate foundation in statistical analysis. With the consent of their advisor and the graduate coordinator, qualified students may substitute more specialized statistics courses or courses in such areas as geographical information systems (GIS). (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall)

CRIM-702 Pro-Seminar in Research Methods
This seminar will focus on the principles and techniques of research with a special focus on evaluation research. The course will cover research conceptualization and design, development of appropriate measures, collection and analysis of data using a wide range of methods. Students will gain a thorough understanding of the research process as well as the policy implications and consequences of research and evaluation. Students will also begin to develop thesis research proposals. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall)

CRIM-703 Advanced Criminology
This course will provide students with a detailed understanding of the theories that have guided criminological research and policy. Subject matter will cover the major influences in criminology: the classical school, the Chicago School, strain theories, socialization and learning theories, and conflict theories, among others. The prerequisite for this course will be a strong undergraduate foundation in theories of crime and criminality. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Spring)

CRIM-704 Crime, Justice and Community
This course provides an overview of the role of communities in crime and criminal justice. The course begins by preparing a foundation in community theory. Students will gain an understanding of the critical dimensions and attributes which define community. The course will emphasize how these critical community dimensions are related to both crime and criminal justice. The course will involve an examination of community-based theory and research, with a special emphasis on the criminology of place and how crime and justice patterns are embedded in particular social structures and cultures. We will discuss the extent to which structural characteristics (e.g., poverty, residential mobility, etc.) and social processes (e.g., social capital, collective efficacy, etc.) are related to crime and disorder. The course will also examine the potential that exists within criminal justice to intervene in communities to reduce crime and disorder and build community in the process. Central to this will be a discussion of co-production (i.e., the intersection between formal and informal social control). (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Spring)

CRIM-705 Interventions and Change in Criminal Justice
This course will focus on theory and research regarding the effectiveness of broad anti-crime strategies and specific intervention efforts at the local, state, national and international level. Theoretical explorations of crime and ideological orientations towards crime will be linked with the crime control and prevention strategies associated with those perspectives. Each strategy of crime control/prevention (including deterrence, incapacitation, rehabilitation, and community crime prevention) will be assessed in terms of research findings on its effectiveness. Detailed attention will be given to prevention/control strategies aimed at both juvenile and adult offenders. Programs will also be examined in the broader context of the ideology and philosophy of justice. Students will become familiar with the state of the art in crime and justice related interventions by studying the theory, practice and evaluation of contemporary crime and justice interventions. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Spring)

CRIM-706 Current Issues in CJ
This course provides an examination of current issues in criminal justice with an emphasis on the application of evaluation, management, theory and ethics to analysis of criminal justice policy. The goal is to engage students in discussion of current issues with their peers and with experts in the field. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall)

CRIM-710 Pro-Seminar in Law and Policy
The course will consider the processes of policy development and analysis in criminal justice with a particular emphasis on the intersection of policy and law. The legal and political environments of criminal justice policy will be examined in study of the development of federal crime policy. Additionally, the roots, development, legal context and impact of major policies such as contemporary policing strategies, problem solving courts and restorative justice will be explored. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Biannual)

CRIM-711 Directed Readings in Criminal Justice
This course will be tailored to individual students’ research interests as they explore areas of inquiry that may become topics for their thesis research. An emphasis will be placed on building a theoretically informed research question via existing literature and research in criminal justice and other disciplines (economics, psychology, sociology, and so on). Parallel to that effort, students will work to identify locally relevant research questions, potential research designs, and possible projects and/or agencies with whom to conduct this research. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall)

CRIM-712 Crime and Media
This course is designed to analyze and critique the mainstream media’s coverage of criminal justice issues, and to study how that coverage impacts society at large. The course will scrutinize, compare and contrast crime coverage of different eras, and will also discuss how that coverage is changing today with around-the-clock media outlets and ubiquitous social media. Among the issues studied will be the impact of crime coverage on public policy; the impact of televised trials; the editorial decisions made daily in newsrooms across America about the placement and priority of crime news; the trademarks that can catapult a crime story into local, regional or even national prominence; and the occasional alliances between law enforcement and media. Lecture 3, Credits 3 (Biannual)

CRIM-775 Criminal Justice Capstone
The criminal justice capstone involves guided research on a topic approved by the instructor. The capstone requires students to develop, design and complete an original research project. Satisfactory completion involves the execution of a substantial research paper and includes a public oral presentation. Lecture, Credits 3 (Fall, Spring)

CRIM-799 Independent Study
A program of study executed by an individual student with assistance and guidance by an instructor, outside a regular classroom setting. Guidelines for designing and gaining approval for an independent study are provided in College of Liberal Arts Policy 1.D. Independent Study, Credits 1 - 6

CRIM-890 Continuation of Thesis
The Continuation of Thesis offers the opportunity to fulfill the work plan agreed by the student and the thesis adviser in commencing the thesis project in criminal justice. The goal of the course is to complete the thesis research proposed in a thesis proposal. Continuation, Credits 0 (Fall, Spring, Summer)

English
ENGL-781 Introduction to Natural Language Processing
ENGL 781 is a graduate-level counterpart to ENGL 481. Students enrolled under the graduate-level number will be required to read the additional graduate-level reading; meet with the professor and other graduate students enrolled outside of class for an additional weekly discussion session; and produce an individual final project that connects with their thesis work; and produce an individual final project that connects with their thesis work. This course provides theoretical foundation as well as hands-on (lab-style) practice in computational approaches for processing natural language text. The course will have relevance to various disciplines in the humanities, sciences, computational, and technical fields. We will discuss problems that involve different components of the language system (such as meaning in context and linguistic structures). Students will additionally work on modeling and implementing natural language processing and digital text solutions. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall)

ENGL-782 Advanced Topics in Computational Linguistics
Study of a focus topic of increased complexity in computational linguistics. The focus topic varies each semester. Students will develop skills in computational linguistics analysis in a laboratory setting, according to professional standards. A research project plays a central role in the course. Students will engage with relevant research literature, research design and methodology, project development, and reporting in various formats. ENGL 782 is a graduate-level counterpart to ENGL 582. Students enrolled under the graduate-level number will be required to read the additional graduate-level reading; meet with the professor and other graduate students enrolled outside of class for an additional weekly discussion session; produce an annotated bibliography linking the thematic focus topic to their thesis or capstone project; and produce an individual final project that connects with their thesis or capstone work. Lecture 3, Credits 3 (Spring)
Experimental Psychology

PSYC-640 Graduate Statistics
This course reviews descriptive and inferential statistics. Basic and advanced conceptual material will be presented to assist students in understanding of diverse data analytic methods, their appropriate application, and to interpret statistical analyses. Topics include one- and two-sample inferencial procedures, interval estimation, correlation, nonparametric tests, linear regression, and analysis of variance. Students will learn to integrate concepts with computer applications. Course content will be taught through lectures, discussion, and applied data analysis exercises. Student mastery of the material will be evaluated through small group discussion of data set analyses, written results of the analyses following APA style, and two exams. (AEEPSYC-MS) Lecture, Credits 3 (Fall, Spring, Summer)

PSYC-641 Applied Psychology Methods
This course explores various types of applied research methods as well as important methodological issues and concepts in areas of applied psychology. Methodologies studied include experimentation, quasi-experimentation, content analysis, surveys, and interviews. Methodological issues cover research ethics, reliability, threats to internal and external validity, demand characteristics, volunteer participant problems, and issues in sampling. (AEEPSYC-MS) Lecture, Credits 3 (Fall)

PSYC-642 Graduate Research Methods
This course provides students with sufficient background in the skills and knowledge necessary to be able to conduct psychological research on a wide variety of problems. In addition to introducing students to numerous research methods used in the discipline, the course will also assist students in planning their thesis research proposal. In parallel with covering core topics in research methodology (such as varieties of data, the role of theory and models in science, psychophysiological methods, subjective methods, and experimental design) the course is designed to guide students through the process of creating a feasible research proposal. Students will also use data to test their designs and practice their analyses. (AEEPSYC-MS) Lecture, Credits 3 (Fall, Spring, Summer)

PSYC-699 Psychology Co-op
Co-op in Psychology. Co-op, Credits 0

PSYC-711 Graduate Biopsychology
A graduate level introduction to the field of behavioral neuroscience, the study of neurobiological, psychological and social bases of human behavior. Topics include neuroanatomy and histology, localization of function, brain injury, research methods in behavioral neuroscience, and physiological basis of learning, memory, motivation, emotion, consciousness states, and behavior. (AEEPSYC-MS) Lecture, Credits 3 (Spring)

PSYC-712 Graduate Cognition
This course will survey theoretical and empirical approaches to understanding the nature of the mental processes involved in attention, object recognition, learning and memory, reasoning, problem solving, decision-making, and language. The course presents a balance between historically significant findings and current state-of-the-art research. Readings that have structured the nature and direction of scientific debate in these fields will be discussed. The course also includes discussions of methodology and practical applications. Students will have opportunities to develop their research skills and critical thinking by designing research studies in cognitive psychology. (AEEPSYC-MS) Lecture, Credits 3 (Spring)

PSYC-714 Graduate Engineering Psychology
In this course the students will learn to recognize the integrated (systems) nature of Engineering Psychology, the centrality of human beings in systems design, and to use the topics covered and the available knowledge base to adapt the environment to people. This course will cover several fundamental models of human information processing in the context of human-system interactions. The models may include but are not limited to Signal Detection Theory, Information Theory, theories of attention, both normative and naturalistic decision-making models, Control Theory, and the Lens Model of Brunswik, as well as models of the human as a physical engine, that is, anthropometry, biomechanics, and work physiology. Most topics include readings in addition to the course text as well as a lab exercise with a detailed lab report. (AEEPSYC-MS) Lecture, Credits 3 (Biannual)

PSYC-715 Graduate Perception
The course is designed to provide students with a deeper understanding of topics in perception. This course will be organized so that students will work in groups on various projects as well as covering topics through readings and classroom discussion. The topics may include, but are not limited to: spatial frequency perception; aftereffects, visual illusions, and their relation to cortical function and pattern perception; color perception; depth and motion perception; higher order perception such as face and object recognition; and music and speech perception. The goal is to cover current research and theories in perception, looking at current developments and their antecedents. The course will be divided into various modules. Students will be assigned readings relevant to each section of the course, and will be expected to master the major concepts. Group discussion of the readings will complement lectures where the instructor will present relevant background material. There will also be laboratory time for the students, where they will examine empirical findings in perception, and develop their research skills in the field. (AEEPSYC-MS) Lecture, Credits 3 (Biannual)

PSYC-716 Graduate Social Psychology
This course explores topics related to understanding individuals in a social context. Topics may include, but are not limited to: Social Perception and Social Cognition; Attitudes; Social Identity; Prejudice and Discrimination; Interpersonal Attraction; Close Relationships; Social Influence; Prosocial Behavior; Aggression; Group Behavior; Artificial and Methodological Issues in Social Psychology. Course format is seminar focused on reading assigned texts each week, writing reaction papers, and participating in discussion. Students will also conduct a study on the topic of their choice and present their findings both in an oral and written format. (AEEPSYC-MS) Lecture, Credits 3 (Biannual)

PSYC-717 Advanced Graduate Statistics
This course introduces students to more advanced inferential parametric and non-parametric data-analysis techniques commonly used in psychological research, but not covered (or not covered in depth) in the Graduate Statistics course. These techniques may include, but are not limited to: Reliability Analysis, Multiple Regression, Discriminant Analysis, Logistic Regression, Factor Analysis, Analysis of Covariance, Multivariate Analysis of Variance, Contrast Analysis, Mediator and Moderator Variable Analysis, Non-Parametric Tests, and Multi-level Modeling. The focus is on the conceptual understanding of these statistics, how different statistical procedures are applied in different research methods, how to perform analyses, how to interpret the results in the context of the research question, and how to communicate these results. (Prerequisites: PSYC-640 or equivalent course.) Lecture, Credits 3 (Biannual)

PSYC-718 Seminar in Art and Aesthetics
What is the relationship between art and knowledge, art and truth, art and politics, art and science? What role is played in criticism by art theory, by considerations of the artists' intentions, by ethics and other forms of cultural criticism? What makes an interpretation of an artwork valid or invalid? How is aesthetic value related to other values? The questions discussed are philosophical questions about art and aesthetic experience. The meetings in this course are not lectures but discussions, and participation is required of all students. Since the examples and topics discussed are mostly from the Western canon, familiarity with the history of Western art is recommended. Graduate level elective. (This course is restricted to CIAS Graduate students.) Lecture, Credits 3 (Fall)

PHIL-703 Seminar in Art and Aesthetics
What is the relationship between art and knowledge, art and truth, art and politics, art and philosophical theory? What role is played in criticism by art theory, by considerations of the artists' intentions, by ethics and other forms of cultural criticism? What makes an interpretation of an artwork valid or invalid? How is aesthetic value related to other values? The questions discussed are philosophical questions about art and aesthetic experience. The meetings in this course are not lectures but discussions, and participation is required of all students. Since the examples and topics discussed are mostly from the Western canon, familiarity with the history of Western art is recommended. Graduate level elective. (This course is restricted to CIAS Graduate students.) Lecture, Credits 3 (Fall)

PHIL-799 Independent Study
A program of study executed by an individual student with assistance and guidance by an instructor, outside a regular classroom setting. Guidelines for designing and gaining approval for an independent study are provided in College of Liberal Arts Policy I.D. (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1 - 6 (Fall, Spring, Summer)
Public Policy

PUBL-610 Technological Innovation and Public Policy
Technological innovation, the incremental and revolutionary improvements in technology, has been a major driver in economic, social, military, and political change. This course will introduce generic models of innovation that span multiple sectors including: energy, environment, health, and bio- and information-technologies. The course will then analyze how governments choose policies, such as patents, to spur and shape innovation and its impacts on the economy and society. Students will be introduced to a global perspective on innovation policy including economic competitiveness, technology transfer and appropriate technology. Lecture, Credits 3 (Fall)

PUBL-620 Information and Communications Policy
This course examines how federal and international policies are developed to influence innovation in, and regulation of, information, computer and telecommunications technologies. In particular the course will examine such topics as privacy, freedom of speech, cybersecurity, intellectual property rights, access to information technology, and regulation of the Internet. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 3 (Fall)

PUBL-630 Energy Policy
This course provides an overview of energy resources, technologies, and policies designed to ensure clean, stable supplies of energy for the future. The course evaluates the impacts of fossil fuel, renewable energy, and hydrogen technologies on society and how public policies can be used to influence their development. The development of U.S. energy policy is of particular concern, although a global perspective will be integrated throughout the course. Lecture, Credits 3 (Spring)

PUBL-699 Public Policy Graduate Co-Op
One semester of paid work experience in a professional setting related to the communication major. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Co-op, Credits 0 (Fall, Spring, Summer)

PUBL-700 Readings in Public Policy
An in-depth inquiry into key contemporary public policy issues with an emphasis on environmental policy and information and communications technology policy. Seminar, Credits 3 (Fall)

PUBL-701 Graduate Policy Analysis
This course provides graduate students with necessary tools to help them become effective policy analysts. The course places particular emphasis on understanding the policy process, the different approaches to policy analysis, and the application of quantitative and qualitative methods for evaluating public policies. Students will apply these tools to contemporary public policy decision making at the local, state, federal, and international levels. Lecture, Credits 3 (Fall)

PUBL-702 Graduate Decision Analysis
This course provides students with an introduction to decision science and analysis. The course focuses on several important tools for making good decisions, including decision trees, including forecasting, risk analysis, and multi-attribute decision making. Students will apply these tools to contemporary public policy decision making at the local, state, federal, and international levels. Lecture, Credits 3 (Spring)

PUBL-703 Evaluation and Research Design
The focus of this course is on evaluation of program outcomes and research design. Students will explore the questions and methodologies associated with meeting programmatic outcomes, secondary or unanticipated effects, and an analysis of alternative means for achieving program outcomes. Critique of evaluation research methodologies will also be considered. Lecture, Credits 3 (Spring)

PUBL-705 Seminar: Advanced Methods
This course will cover the major theoretical and applied analytical methods and techniques in both quantitative and qualitative analysis. An emphasis will be placed on integrating empirical and normative concerns. Lecture, Credits 3 (Spring)

PUBL-709 Public Administration and Management
This course provides an in-depth look at the evolution of public administration theory and practice. Starting with the basic structure of the U.S. Constitution, the course examines how the key tensions facing local, state, and federal public administrators changed over time with both changes in social science and changes in public administration practice. Topics include public organization theory, public budgeting, citizen engagement, e-government, public-private partnerships, and recent innovations in management practice. Lecture, Credits 3 (Fall)

PUBL-730 Telecommunications Policy and Issues
The objective of this course is to enlighten students relative to telecommunications policy and standards sufficiently, in order for them to be able to deal with the real-world issues that confront telecommunications professionals on a daily basis. Students will not be prepared to act as regulatory experts or to replace specialized experts with legal training, but should be sufficiently cognizant of pertinent issues to know when it is prudent to call in such forces. The domestic as well as the international regulatory, policy and standard arenas will be explored. This course helps students to understand that the telecommunications environment is greatly effected by technology, policy, security and market forces with a primary focus on telecommunications policy and all that it entails. Lecture, Credits 3 (Fall)

PUBL-788 Graduate Research Experience
Gives the student first-hand experience in designing and performing research. Students are closely supervised by a faculty member, developing their pre-professional skills while learning how to do research first hand. Allows examination of a special problem or topical area in the field of Public Policy at the graduate level. Topics and specific content and methods vary from year to year or term to term. Research, Credits 0 - 6 (Fall, Spring, Summer)

PUBL-789 Public Policy Graduate Special Topics
Allows examination of a special problem or topical area in the field of Public Policy at the graduate level. Topics and specific content and methods vary from year to year or term to term. Lecture 3, Credits 3 (Fall, Spring)

PUBL-810 Technology, Policy and Sustainability
This course introduces students to public policy and its role in building a sustainable society. The course places particular emphasis on the policy process; the relationship among technology, policy, and the environment; and policy mechanisms for addressing market and government failures that threaten sustainability. Lecture, Credits 3 (Fall, Spring)

School Psychology

SPSY-600 Field Experience I: Professional School Psychology Foundations
The purpose of the course is to introduce students to the field of school psychology. The student will participate in field and in-class activities enabling them to obtain firsthand knowledge and familiarity with the roles and functions of school psychologists, along with an introduction to the expected competencies required of school psychologists by state and national accrediting bodies. Field experiences will also give students the opportunity to gain firsthand knowledge and familiarity with school systems, collaborative problem solving, micro-skills in counseling, classroom management, and relevant professional and legal issues. (SCPSYC-ACT, SCPSYC-MS) Lecture, Credits 3 (Fall)

SPSY-601 Field Experience II: Professional School Psychology Foundations
The purpose of the course is to continue to immerse students in the field of school psychology. The student will participate in field and in-class activities enabling them to obtain firsthand knowledge and familiarity with current topics and issues that impact the field of school psychologists. Field experiences will also give students the opportunity to gain firsthand knowledge and familiarity with the necessary competencies required of school psychologists by state and national accrediting bodies. These competencies and topics include but are not limited to: collaborative problem solving, bullying, learning disabilities, evidence based interventions, counseling, consultation, classroom management, applied behavioral interventions, curriculum based measurement, and relevant professional and legal issues. (SCPSYC-ACT, SCPSYC-MS) Lecture, Credits 3 (Spring)

SPSY-603 Ethical and Legal Issues
Students of this course will study assessment generally, types of tests and their uses, strengths and weaknesses of specific instruments, principles of reliability and validity, scales, and norms. Students will acquire an understanding of the quantitative and qualitative aspects of measurement. Extensive practice will be given in the administration and scoring of standardized assessment procedures. Emphasis will be placed on the use of various academic assessment procedures in schools and other settings. (SCPSYC-ACT, SCPSYC-MS) Lecture, Credits 3 (Fall)

SPSY-630 Academic Assessment
This course concentrates on the development of theory and applied skills in intellectual assessment. Students learn to select and administer individual intelligence tests, to interpret results, to form test-based recommendations for intervention, and to provide written and oral reports. Assessment of persons who are culturally different or disabled is emphasized. (SCPSYC-ACT, SCPSYC-MS) Lecture, Credits 3 (Spring)
SPSY-632 Social-Emotional Assessment
This course uses interviews, behavioral observations, rating scales, and projective measures for the assessment of child and adolescent personality and adaptive behavior. Students gain experience in administering, interpreting, and reporting results of measures currently used in the practice of psychology in the schools. Lecture, Credits 3 (Spring)

SPSY-640 Statistics
This course reviews descriptive and inferential statistics. Basic and advanced conceptual material will be presented to assist students in their understanding of diverse data analytic methods, their appropriate application, and how to interpret statistical analyses. Topics include one- and two-sample inferential procedures, interval estimation, correlation, nonparametric tests, linear regression, and analysis of variance. Students will learn to integrate concepts with computer applications. Course content will be taught through lectures, discussion, and applied data analysis exercises. Student mastery of the material will be evaluated through small group discussion of data set analyses, written results of the analyses following APA style, and two examinations. This course is required for all students matriculating in the School Psychology Program. Non-matriculating students may take the course with instructor approval. (SCPSYC-ACT, SCPSYC-MS) Lecture, Credits 3 (Fall)

SPSY-641 Research Methods
This course explores various types of research methods as well as important methodological issues and concepts. Methodologies studied include experimentation, quasi-experimentation, content analysis, surveys, and interviews. Methodological issues cover research ethics, reliability, threats to internal and external validity, demand characteristics, volunteer participant problems, and issues in sampling. (SCPSYC-ACT, SCPSYC-MS) Lecture, Credits 3 (Spring)

SPSY-650 Applied Behavior Analysis
This course reviews scientifically-based principles, concepts, and methods of behavior analysis. Topics covered include behavioral assessment, data analysis, and approaches to behavior change. A special focus is on the functional behavioral assessment process within schools. Students will learn to develop assessment-based behavior intervention plans, which are tailored to the unique needs of individual students, through a collaborative problem-solving process involving families and school staff. (SCPSYC-ACT, SCPSYC-MS) Lecture, Credits 3 (Spring)

SPSY-701 Advanced Practicum I: Issues in Diversity
The purpose of the course is for students to continue to participate in supervised field experiences in school/clinical settings along with a didactic component emphasizing the development and application of a multicultural and contextual lens within their field experiences. Students will gain knowledge necessary to work effectively with students from a wide variety of contextual, cultural, and linguistic backgrounds. Topics include but not limited to: multicultural theory, culture, cultural identity, social class, race and ethnicity, gender issues, religion and spirituality, and sexual orientation. (Prerequisites: SPSY-600 and SPSY-601 or equivalent courses.) Lecture, Credits 3 (Fall)

SPSY-702 Advanced Practicum II: Issues in Diversity
The purpose of the course is for students to continue to participate in supervised field experiences in school/clinical settings along with a didactic component emphasizing the development and application of a multicultural and contextual lens within their field experiences. Students will begin to apply their knowledge and available resources to further develop the skills necessary to work effectively with students from a wide variety of contextual, cultural, and linguistic backgrounds. Topics include but not limited to: ecological models, developmental contextualism, oppression, resilience, privilege and power, immigration and acculturation, and multicultural assessment. (Prerequisites: SPSY-600 and SPSY-601 or equivalent courses.) Lecture, Credits 3 (Spring)

SPSY-711 Graduate Biopsychology
A graduate level introduction to the field of behavioral neuroscience, the study of neurobiological basis of cognition and behavior. Topics include neuro-anatomy and physiology, localization of function, brain injury, memory, research methods in behavioral neuroscience, and biological basis of learning, language, memory, emotion, conscious states, sexual behavior, etc. (SCPSYC-ACT, SCPSYC-MS) Lecture, Credits 3 (Fall, Spring)

SPSY-720 Advanced Consultation
This course focuses on the development of beginning competencies in consultation that will help students assist school professionals in building capacity to deliver effective services. Contextual influences on school consultation, models of consultation, and the stages of the consultation process within a problem-solving model will be emphasized. Issues relevant to individual case consultation and systems-level consultation will be covered. (Prerequisites: SPSY-620 or equivalent course.) Lecture, Credits 3 (Fall)

SPSY-721 Academic Intervention
Most referrals to school psychologists involve some sort of learning problem. What variables affect school learning? Are there influences more important than others? Which of these influences are alterable and therefore available as interventions to improve learning? What classroom strategies work best? We will examine theories of school learning and the basic psychological principles that apply to teaching and learning. This will be accomplished through the examination of the role of teachers, which includes their responsibility for teaching curriculum, classroom management, and the social and emotional growth of students. Students will learn to critically evaluate the instruction provided to a particular student in a given content area. In addition, students will learn to assess academic functioning within the learning environment, identify specific target areas for intervention, set appropriate goals and objectives, monitor student progress toward those goals and objectives, and evaluate the effectiveness of the intervention(s) in place as a result of the assessment. Students are expected to leave this course with a cursory understanding of the problem-solving process and the development and monitoring of effective interventions, and basic competence in applying this process. (Prerequisites: SPSY-650 or equivalent course.) Lecture, Credits 3 (Spring)

SPSY-722 Advanced Counseling
This course focuses on the refinement of counseling skills used with children and adolescents in individual and group counseling. Students will integrate theory, research and processes relative to individual and group work within cognitive-behavioral and solution-focused theoretical models. Students will consult with parents and teachers as they develop treatment plans, counseling interventions, progress monitor interventions, and write recommendations. Crisis intervention and group behavior management will also be addressed. This course is offered to second-year students matriculating in the school psychology program. (Prerequisites: SPSY-620 or equivalent course.) Lecture, Credits 3 (Fall)

SPSY-723 Systems and Organizational Interventions
This course will assist students in building their consultation skills, with an explicit focus on systems-level issues and interventions. Students will learn principles of population-based prevention and intervention services and family-school collaboration. An array of evidence-based schoolwide interventions will be explored in depth with a focus on the role of the school psychologist within the larger system. (Prerequisites: SPSY-620, SPSY-630, SPSY-650, SPSY-720 and SPSY-721 or equivalent courses.) Lecture 3, Credits 3 (Spring)

SPSY-730 Comprehensive Assessment Integration
This is an applied course in linking the diagnostic assessment of exceptional children and adolescents to recommendations for appropriate interventions. Students learn to select and develop a plan of assessment for a variety of referral questions. Students continue to learn and expand their skills in administering tests. Students primarily learn to interpret, and integrate test data and report the results and recommendations for parents, teachers and multidisciplinary evaluation teams. This course is offered to second-year students matriculating in the School Psychology Program. (Prerequisites: SPSY-631 and SPSY-632 or equivalent courses.) Lecture, Credits 3 (Fall)

SPSY-750 Internship
The 1200-hour internship is the culminating experience in the school psychology program. It provides an intensive, supervised training experience in which interns put the knowledge, skills, and attitudes learned during their training program into practice while continuing to develop and expand upon those abilities. The internship year is a broad-based, individualized experience that provides an opportunity to work with a variety of children, parents, teachers, support staff, and administrators. Interns are exposed to a variety of educational meetings, programs, workshops, resources, and conferences through their internship sites. Monthly class seminars supplement the supervised training experience. (All Coursework completed and Faculty Approval) (Enrollment in this course requires permission from the department offering the course.) INT, Credits 3 (Fall, Spring, Summer)

SPSY-753 Thesis
This course provides students with the opportunity to conduct original research. The purpose of the course is for students to apply concepts they learn in research methods and inferential statistic course as well as experience the scientific method at a deeper level. The thesis is an optional requirement for those in the MS School Psychology program, however, it is a requirement for the Advanced Graduate Certificate. (Permission from instructor) (This course requires permission of the Instructor to enroll.) Thesis, Credits 1 (Fall, Spring)

SPSY-757 Special Topics in School Psychology
This course is designed to allow the student to focus on a given special topic or area of research relative to school psychology. Such topics or activities may include selected readings, assessment techniques, direct intervention skills, or indirect intervention skills. This course may be offered from 1 to 3 credit hours depending on the specific topic covered. (SCPSYC-ACT, SCPSYC-MS) Lecture 3, Credits 1 - 3 (Fall, Spring)
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<tr>
<td>STSO-621</td>
<td>Graduate Biodiversity and Society</td>
<td>This course explores the problems, issues, and values stemming from the current massive loss of biodiversity. Various justifications for preserving or conserving biodiversity will be examined. Although principals of conservation biology are presented, the social/cultural dimensions of the issue will be emphasized. (This class is restricted to degree-seeking graduate students or those with permission from instructor.)</td>
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<td>STSO-710</td>
<td>Graduate Science and Technology Policy Seminar</td>
<td>Examines how Federal and international policies are developed to influence research and development, innovation, and the transfer of technology in the United States and other selected nations. Students in the course will apply basic policy skills, concepts, and methods to contemporary science and technology policy topics. (This class is restricted to degree-seeking graduate students or those with permission from instructor.)</td>
<td>3</td>
<td>Fall</td>
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<tr>
<td>STSO-750</td>
<td>Graduate Sustainable Communities</td>
<td>The concept of sustainability has driven many national and international policies. More recently, we have become aware that unless we physically build and rebuild our communities in ways that contribute to sustainability, making progress toward that goal is unlikely. It is equally important to recognize the social/cultural context of sustainability. In addition, it is at the local level that the goals of equity (a key consideration in community sustainability), most often achieved through citizen participation and collaborative processes are most easily realized. This course will broaden students understanding of the concept of sustainability, particularly the concept of social sustainability. This course focuses on sustainability as a way to bring light to the connections between natural and human communities, between nature and culture, and among environmental, economic, and social systems. Working closely with local organizations, students will explore the applicability of theoretical concepts. (This class is restricted to degree-seeking graduate students or those with permission from instructor.)</td>
<td>3</td>
<td>Fall</td>
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<tr>
<td>STSO-789</td>
<td>STSO Graduate Special Topics</td>
<td>Allows examination of a special problem or topical area in the field of STS or Environmental Studies at the graduate level. Topics and specific content and methods vary from year to year or Semester to Semester. (This class is restricted to degree-seeking graduate students or those with permission from instructor.)</td>
<td>3</td>
<td>Fall, Spring</td>
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BUSI-710 Project Management
This course addresses project management from a multidisciplinary perspective, covering the fundamental nature of and techniques for managing a broad range of projects — public, commercial, and non-profit. Topics cover the Project Management Life Cycle from Planning to Termination. It also addresses the behavioral and quantitative facets of project management, as well as the use of spreadsheet models, project management software, and simulation for risk analysis software. Also covered are PERT, CPM, Learning Curves, and EVA. Introduces the Framework and 10 Knowledge Areas of A Guide to the Project Management Body of Knowledge (PMBOK® Guide) as defined by the Project Management Institute (PMI). Project Management is available in on-campus and on-line formats. "Note: Students who have taken BUSI 510 may not register for or receive credit for BUSI-710." Lecture 3, Credits 3 (Fall, Spring, Summer)

BUSI-712 International Project Management
With the increasing frequency of globalization, mergers, and acquisitions, international projects are becoming more prevalent and approaching the norm for many organizations. This course addresses a wide range of international projects — based in different industries and multiple countries. It deals with cultural and social differences within firms; cultural and social differences among countries and within countries; languages and dialect variations; different management practices and structures; religious practices; legal, regulatory, and reporting requirements; technology and infrastructure differences in different regions; and time zone differences. Incorporates aspects of A Guide to the Project Management Body of Knowledge (PMBOK® Guide). (Prerequisite: BUSI-711 or equivalent course.) Lecture 3, Credits 3 (Fall, Spring, Summer)

BUSI-711 Advanced Project Management
Advanced Project Management covers the topics necessary for implementation of and excellence in project management. It deals with turning the principles and theory of project management into practice. The course addresses the best practices for project management in the world; project portfolio management and ROI; the project office and Six Sigma; project risk management and integrated projects; corporate cultures, behavior, and cultural failures; informal, adaptive, and extreme project management; and critical chain project management. It integrates aspects of A Guide to the Project Management Body of Knowledge (PMBOK® Guide). Advanced Project Management is available in on-campus and on-line formats. (Prerequisite: BUSI-710 or equivalent course.) Lecture 3, Credits 3 (Fall, Spring, Summer)

PROF-770 Capstone Proposal Seminar
This course guides the student through the preparation of the Capstone Proposal that is required for the applied final course of their MS in Professional Studies degree - the Capstone Project. The student will determine a Capstone Project concept, and articulate the methods for implementing the Capstone Project. The course concludes with a paper describing the Capstone Project, including background and description, methodology, anticipated outcomes, and probable Capstone Advisor. Student will meet regularly with the course facilitator. Upon successful completion of this course, student will be registered for the Capstone Project. (Pre-requisites: PROF-705 and core coursework; course restricted to MS in Professional Studies students) Class 0, Lab 0, Credit 0 (F, S, Su) Seminar 3, Credits 0 (Fall, Spring, Summer)

PROF-775 Capstone Project
The capstone course for students enrolled in the MS in Professional Studies Degree program. With individualized advising from a faculty advisor, students participate in a real world problem solving project carried out in an organizational setting. Problems selected for project work relate to a student’s professional course concentrations. Course requirements involve completing a literature review, writing a project proposal, engaging in online discussion with faculty advisor and other CMS capstone students, various kinds of field work carried, writing full draft and final academic reports and making a (Powerpoint) presentation. Registration completed on behalf of students following faculty review of acceptable capstone project proposal. (Prof 770; Department approval) Class 3, Credit 3 (F,S,Su) Project 3, Credits 1 - 6 (Fall, Spring)

PROF-780 Continuation of Capstone Proj Continuation of Capstone Proj (Prerequisites: PROF-775 or equivalent course.) Continuation, Credits 0 (Fall, Spring, Summer)

PROF-799 Special Topics
Special topics are experimental courses announced as offered. Variable credit. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall, Spring, Summer)

TCOM-621 Proposal Writing
This course focuses on reviewing examples of the elements of proposal responses and practicing creating those elements. Students learn the process of evaluating and responding to RFPs with concentration on making bid decisions, organizing teams, identifying strategies, establishing credibility, ensuring technical clarity, taking advantage of technology, applying creativity, and writing persuasively. Topics include the proposal process that is practiced by government, industry, and grant-funding agencies. “Note: co-listed with TCOM-414.” Lecture 3, Credits 3 (Spring)

TCOM-644 Science Writing
Course introduces students to the writing process for describing scientific and technological subject matter for presentation to general audiences. Students will learn to gather needed source material and organize, write and edit articles that cover developments in the scientific and technological communities. Various article formats used in professional, in-house, trade and popular publications are presented. “Note: co-listed with TCOM 444. Students cannot receive credit for both.” Lecture 3, Credits 3 (Fall)
This course focuses on the history and understanding of existing diversities within the Deaf and Hard-of-Hearing communities, and in ways in which teaching can most effectively meet the needs and interests of these students for effective learning. Readings and discussions will explore the educational needs of Deaf and Hard-of-Hearing students with variations of experience related to culture, race/ethnicity, language, educational, and socio-economic backgrounds and settings, communication skills, and learning styles. These concepts will be applied to effective teaching and curriculum development. (SEDDEAF-MS) Lecture 3, Credits 3 (Fall)

MSSE-703 Special Education in the Social Context
This course focuses on the sociological approach to disability and the historical foundations of special education. Three models of disability are introduced: medical, social, and political. These three models provide a foundation for the course, and guide study of three major aspects of disability and special education. First, the class will explore how each of these models has historically guided and, in some cases, continues to guide services and social institutions for persons with disabilities, including educational and rehabilitation services. Second, the course will examine the processes through which people with disabilities are so labeled and the interaction between these individuals and others (family, peers, school, community). Third, the course will analyze the changing roles of the health professions (professional teachers) and the ways in which professional preparation programs reflect the various models of disability. The course will draw heavily on a variety of philosophical, theoretical, conceptual and methodological perspectives, including phenomenology, symbolic interaction, and human ecology. (SEDDEAF-MS) Lecture 3, Credits 3 (Fall)

MSSE-704 Teaching Deaf and Hard of Hearing Learners with Special Educational Needs
This course focuses on providing students with basic information regarding the needs of deaf and hard of hearing learners with special educational needs, including (1) developmental disability, (2) emotional or behavioral disorder (3) learning disability, attention deficit disorder or attention deficit hyperactivity disorder, or (4) visual impairment. Topics include incidence, identification, assessment, teaching strategies, and working with parents. The goal is to enable students to see students in a holistic fashion, and thus will include the perspectives of parents, teachers and deaf and hard of hearing learners with special educational needs. Learning strategies may include site visits, presentations, films, and interactive workshop style classes offered by experienced teachers, psychologists, counselors, disability advocates, and parents of learners with special educational needs. The course will regularly incorporate guest lecturers who have specialized expertise in teaching or research in one or more of the topic areas covered in the course. (Prerequisites: MSSE-703 or equivalent course and graduate standing in SEDDEAF-MS.) Lecture 3, Credits 3 (Spring)

MSSE-710 General Instructional Methods
This introductory course provides an overview of the current theories of assessment, curriculum, instruction, and learning across diverse educational settings in the field of deaf education. The course covers the use of educational technologies to enhance the learning experiences of deaf students and options for classroom management, learning environment appropriate to K-12 classrooms, and methods for assessment. Reflection and application of effective instructional practices are demonstrated through microteaching and field-based experiences. To progress to MSSE-714 Practicum, student must obtain a grade of at least B in this course. (SEDDEAF-MS) Lecture 3, Credits 3 (Fall)

MSSE-712 Practicum
As required by the New York State Education Department, each MSSE student is required to complete 100 hours of practicum experience during their first year in the program. This practicum experience provides students with opportunities to observe and reflect on their content, professional, pedagogical knowledge, skills and dispositions in classroom settings at both schools for the deaf and mainstreamed programs. There will also be course-related observations. Students will also be required to attend selected Deaf culture events. After completion of all the required observations, the students are required to submit a practicum experience portfolio. Guidelines will be provided to the student. The practicum experience must be completed with a grade of at least a B before the first student teaching assignment. (Prerequisites: MSSE-710 or equivalent course with a minimum grade of B and graduate standing in SEDDEAF-MS.) Lecture, Credits 2 (Spring)

MSSE-713 Assessment Principles and Practices
This course addresses assessment as educational decision-making, involving the selection and interpretation of assessment tools as applied to classroom-based student learning. The course focuses on students who are deaf and hard of hearing; including students with diverse learning needs. Assessment and educational planning, the economic and political perspectives, and the history of educational assessment methods, communication strategies, and psycho-educational approaches. (SEDDEAF-MS) Lecture 3, Credits 3 (Spring)

MSSE-714 Curriculum Content and Methods of Instruction
Note: There are five discipline-specific courses here, designated by section: 01 (English), 02 (Mathematics), 03 (Science), 04 (Social Studies) and 05 (American Sign Language). Students will take only the section focusing on the content area in which they will be certified. Section 01 English. This course examines issues and methods related to teaching English in the secondary level to students who are Deaf or Hard-of-Hearing. Students investigate and analyze current approaches to curriculum, instruction and materials in the area of English instruction through readings, observations, and seminars. Students design content area projects to demonstrate a variety of methodological philosophies. Section 02 Mathematics. This course examines issues and methods related to teaching mathematics at the secondary level to students who are Deaf or Hard-of-Hearing. Current instructional methods, curriculum and professional resources in mathematics are studied through seminars, readings, special projects, observations and work with content-area specialists and teachers in secondary-level mathematics courses. Section 03 Science. This course examines issues and methods in teaching secondary-level science to Deaf or Hard-of-Hearing students, including the selection, modifications, and use of curriculum materials in science. Discussions will be concerned with instructional strategies, classroom management, cognitive development, testing and evaluation, lab report writing and theories of science teaching. Students will be required to observe teachers in secondary level science courses. Section 04 Social Studies. This course examines issues and methods related to teaching social studies at the secondary level to students who are Deaf or Hard-of-Hearing. Through seminars, readings, special projects, and work with content area specialists/teachers, current instructional methods, curriculum and professional resources in social studies are examined. Students will be required to observe teachers of secondary level social studies courses at public schools, residential schools for Deaf students or in mainstream programs. Section 05 American Sign Language. This course examines issues and methods related to teaching American Sign Language at the secondary level. Students investigate and analyze current approaches to ASL curriculum, instruction, and materials through readings, observations, and seminars. Students design content area projects to demonstrate their understanding of teaching theories and methods, curriculum design, and evaluation techniques. To progress to MSSE-760, students must obtain a minimum grade of B in this course. (Prerequisites: MSSE-710 and MSSE-712 or equivalent course with a minimum grade of B and graduate standing in SEDDEAF-MS.) Lecture 3, Credits 3 (Fall)

MSSE-715 Issues in Mainstreamed Education
This course will prepare students to work with Deaf and Hard of Hearing children and youth with a broad range of disabilities and educational needs in mainstreamed school settings. The course is designed to foster acceptance of diversity among individuals as well as to develop skills in writing appropriate Individualized Education Plans (IEPs), including behavior modification methods, communication strategies, and psycho-educational approaches. (SEDDEAF-MS) Lecture 3, Credits 3 (Fall)

MSSE-722 Educational Audiology and Spoken Language Development
This course provides a basic understanding of the mechanisms of hearing and speech and causes of hearing loss. Emphasis is placed on development of a functional understanding of speech perception, speech development, hearing aids, cochlear implants, and assistive listening devices. Procedures for audiological and speech/language assessment are examined, together with strategies for supporting use and development of spoken language in the classroom. (SEDDEAF-MS) Lecture 3, Credits 3 (Fall)

Graduate Course Descriptions
College of Science

**MSSE-725 Structures of American Sign Language and English**
This course concentrates on the linguistic structures of American Sign Language (ASL) and English. This course introduces students to the structural description of ASL and English languages at various levels (phonology, morphology, syntax, semantics, and discourse/pragmatics). Issues related to language change and variation, language use in contact situations (for example, code-switching), and language use in education will be discussed. (SEDDEAF-MS) Lecture 3, Credits 3 (Fall)

**MSSE-726 Language Acquisition and Learning**
This course introduces students to current theories of language acquisition and learning in educational settings. The stages of acquisition and learning, and variables that influence these processes will be included. Bilingual and second language acquisition and learning will also be addressed. Implications for instruction with Deaf students will be discussed. (Prerequisites: MSSE-725 or equivalent course and graduate standing in SEDDEAF-MS.) Lecture 3, Credits 3 (Spring)

**MSSE-727 American Sign Language in Instructional Delivery**
This course is designed to improve the ASL proficiency of classroom teachers. It provides students strategies and skill building to teach content areas in and through ASL. Students will enhance their ASL skills for the purpose of conveying concepts to Deaf students accurately. Topics include ASL instructional strategies, curriculum development in ASL, assessment methodologies, student products in ASL, and vocabulary/phrases for effective communication and instructional delivery. (Prerequisites: MSSE-725 or equivalent course and graduate standing in SEDDEAF-MS.) Lecture 3, Credits 3 (Spring)

**MSSE-728 Literacy and the Deaf Adolescent**
This course is designed to familiarize students with the process involved in English literacy development. Particular emphasis is placed on the literacy development of deaf and hard-of-hearing students in grades 7-12. Students learn about various language and literacy instructional methods and how to incorporate literacy instruction into all secondary content area classrooms. (Prerequisites: MSSE-726 or equivalent course and graduate standing in SEDDEAF-MS.) Lecture 3, Credits 3 (Fall)

**MSSE-760 Student Teaching I**
This first assignment consists of 8 weeks (40 days or 250 hours) of teaching and observation. Teacher candidates are placed with cooperating teachers in residential schools for the Deaf or mainstreamed programs. They develop lesson and unit plans and teach in the content area in which they plan to receive New York State certification. To progress to MSSE-761, students must pass this student teaching assignment with a minimum grade of B and submit a student teaching portfolio. (Prerequisites: MSSE-714 or equivalent course with a minimum grade of B and MLAS-202 or equivalent course with a minimum grade of C- and graduate standing in SEDDEAF-MS.) Lecture/Lab, Credits 6 (Spring)

**MSSE-761 Student Teaching II**
This second assignment consists of 8 weeks (40 days or 250 hours) of teaching and observation. Student teachers are placed with cooperating teachers in residential schools for the Deaf or mainstreamed program. They develop lesson and unit plans and teach in the content area in which they plan to receive New York State certification. Students must pass this student teaching assignment with a minimum grade of B and submit a student teaching portfolio. (MSSE-760 & SEDDEAF-MS Prereq) Lecture/Lab, Credits 6 (Spring)

**MSSE-785 Foundations of Educational Research**
This course is an introduction to research and inquiry in education. The course includes the evaluation of selected deaf education research studies, including methodologies, data collection, and analyses, and implications of the studies to teaching and learning. Action research in the classroom is examined in depth. Students will prepare a review of literature and an action research plan related to a specific curriculum topic or problem in the learning/teaching of their content areas. The focus of the course is upon the student as a consumer rather than a practitioner of research, however the student will exit the course with basic practitioner knowledge, especially in the area of teacher research. (SEDDEAF-MS) Lecture 3, Credits 3 (Spring)

**MSSE-789 Special Topics: MSSE**
Special topics courses will be developed based on student interest and demand as well as faculty interest and availability. These courses are usually taken on an elective basis. (SEDDEAF-MS) Independent Study, Credits 1 - 3 (Fall, Spring, Summer)

**MSSE-794 Inquiry in Teaching**
This is an elective enrichment course that facilitates development of scholarship skills in conjunction with the completion of an independent project on an important educational topic. The project may be an experimental study that creates new knowledge, curriculum development that results in a novel and tangible product, a comprehensive review and analysis of a body of literature, or a grant proposal suitable for submission to funding sources. Students will seek a project mentor by the end of their first semester and will work independently under the guidance of that mentor. A committee of program faculty will evaluate the final written report for level of critical thinking, integration of concepts, clarity of expression, and adherence to the principles of scientific inquiry. (Prerequisites: MSSE-785 or equivalent course and graduate standing in SEDDEAF-MS.) Independent Study 3, Credits 3 (Spring)

**MSSE-799 Independent Study: MSSE**
Independent study courses will be developed based on student interest and demand as well as faculty interest and availability. These courses are usually taken on an elective basis. (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1 - 3 (Fall, Spring, Summer)

**Deafness Specialty Preparation Program in Speech-Language Pathology**

**NCOM-720 Cochlear Implants in Children**
Students will learn to make and implement effective clinical decisions that result in optimal care of children with cochlear implants and hearing aids. Students will study deafness in children and the technologies, programs, and services that enhance spoken communication and learning. Students will develop an understanding of the impact of medical, socio-economic, and cultural factors on clinical interventions with children with deafness. (Enrollment in this course requires permission from the department offering the course.) Lecture 3, Credits 3 (Fall)
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Course numbering RIT courses are generally referred to by their alphanumeric registration label. The Four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100-299), upper division (300-599), or graduate level (600 and above).

Unless otherwise noted, the following courses are offered annually. Specific times and dates can be found in each semester’s schedule of courses. Prerequisites/corequisites are noted in parentheses near the end of the course description.

Astrophysical Sciences and Technology

ASTP-601  Graduate Seminar I
This course is the first in a two-semester sequence intended to familiarize students with research activities, practices, and ethics in the university research environment and to introduce students to commonly used research tools. As part of the course, students are expected to attend research seminars sponsored by the Astrophysical Sciences and Technology Program and participate in a weekly journal club. The course also provides training in scientific writing and presentation skills. Credits earned in this course apply to research requirements. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) Seminar 2, Credits 1 (Fall)

ASTP-602  Graduate Seminar II
This course is the second in a two-semester sequence intended to familiarize students with research activities, practices, and ethics in the university research environment and to introduce students to commonly used research tools. As part of the course, students are expected to attend research seminars sponsored by the Astrophysical Sciences and Technology Program and participate in a weekly journal club. The course also provides training in scientific writing and presentation skills. Credits earned in this course apply to research requirements. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) Seminar 2, Credits 1 (Spring)

ASTP-610  Mathematical Methods for the Astrophysical Sciences
This course is a stand-alone course on mathematical methods for astrophysics covering tensor algebra, group theory, complex analysis, differential equations, special functions, integral transforms, the calculus of variations, and chaos. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) Lecture 3, Credits 3 (Spring)

ASTP-611  Statistical Methods for Astrophysics
Statistical Methods for Astrophysics This course provides an introduction to the statistical techniques used in astrophysics and other observational sciences, including parameter estimation, hypothesis testing, and statistical signal processing. An introduction is given to both Bayesian and frequentist approaches. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) Lecture 3, Credits 3 (Spring)

ASTP-617  Astrophysical Dynamics
Hamiltonian mechanics, the two-body system, perturbation theory applied to Keplerian orbits, motion near black holes and the many-body problem. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) Lecture 3, Credits 3 (Spring)

ASTP-651  Radiative Processes for Astrophysical Sciences
This course will cover classical continuum radiation emission mechanisms that commonly occur in astrophysical environments. Topics will include properties of astrophysical radiation, radiative transfer, blackbody radiation, radiation from moving charges, bremsstrahlung, synchrotron, and inverse compton radiation. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) Lecture 3, Credits 3 (Fall)

ASTP-661  Astrophysical Methods
This course provides an introduction to advanced classical dynamics starting from an action principle, and its applications to astrophysical systems. Topics include Lagrangian and Hamiltonian mechanics, the two-body system, perturbation theory applied to Keplerian orbits, motion near black holes and the many-body problem. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) Lecture 3, Credits 3 (Spring)

ASTP-670  Stellar Structure and Atmospheres
An overview of the physical principles governing the internal structures and energy generation mechanisms of main sequence stars, with brief introductions to pre- and post-main sequence stellar evolution. Topics covered include: observational aspects of main sequence stars, giants, and white dwarfs; stellar timescales and equations of state; static stellar structure; stellar energy generation and transport; simple stellar atmospheres. (ASTP-MS or PhD and ASTP-615) Lecture 3, Credits 3 (Fall)

ASTP-730  Galactic Astrophysics
This course will cover stellar and galactic dynamics with special application to the Milky Way galaxy. Topics will include the theory of orbits; Jeans theorem and equilibrium of stellar systems; the virial theorem; the Jeans equations; gravitational instabilities; structure and kinematics of the Milky Way; properties of spiral and elliptical galaxies. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs. Co-requisites: ASTP-617 or equivalent course.) Lecture 3, Credits 3 (Fall)

ASTP-740  Radiative Transfer
Introduction to the laws of radiative transfer. The inverse problem. The inverse problem. The inverse problem. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) Lecture 3, Credits 3 (Fall)

ASTP-750  Extragalactic Astrophysics
This course will cover objects in the universe beyond our own Milky Way galaxy, with an emphasis on the observational evidence. Topics will include properties of ordinary and active galaxies; galaxy clusters; the extragalactic distance scale; evidence for dark matter; cosmological models with and without lambda. (Prerequisites: ASTP-740 or equivalent course.) Lecture 3, Credits 3 (Spring)

ASTP-789  Special Topics
This is a masters-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This course requires permission of the Instructor to enroll.) Lecture, Credits 1 - 3

ASTP-790  Research and Thesis
Masters-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 3 (Fall, Spring, Summer)

ASTP-791  Continuation of Thesis
Continuation of Thesis Continuation, Credits 0 (Fall, Spring, Summer)

ASTP-799  Independent Study
An independent study in an area of astrophysical sciences and technology not covered in the available courses. This study may be reading study of an appropriate textbook, literature review, or other appropriate work. The course requires a formal proposal, faculty sponsor, and program approval. Independent Study, Credits 1 - 4 (Fall, Spring, Summer)
ASTP-831 Stellar Evolution and Environments
A survey of contemporary topics in star formation and pre- and post-main sequence stellar evolution, with emphasis on the physical processes governing stellar accretion, mass loss, and the effects of binary companions on these processes. (Prerequisite: ASTP-730 or equivalent course.) Lecture 3, Credits 3 (Spring)

ASTP-835 High-Energy Astrophysics
This course will survey violent astrophysical phenomena including supernovae, compact stellar remnants, X-ray binaries, gamma ray bursts, and supermassive black holes in active galactic nuclei. It will examine physical processes associated with the emission of high-energy radiation, production of high-energy particles, accretion discs around compact objects, and production and propagation of astrophysical jets. It will review current models for the sources of high-energy phenomena. (Prerequisites: ASTP-615 or equivalent course.) Lecture 3, Credits 3 (Spring)

ASTP-841 The Interstellar Medium
This course provides a detailed overview of the physical processes and structures of the interstellar medium in our Galaxy and other galaxies. The course explores the fundamental physical basis of the observed properties of low-density astrophysical gases observed throughout the universe. Topics may include HII regions, planetary nebulae, HI clouds, molecular clouds, photodissociation regions, supernova remnants, and multi-phase models of the interstellar medium. (Prerequisites: ASTP-615 or equivalent course.) Lecture 3, Credits 3 (Fall)

ASTP-851 Cosmology
This course will cover the evolution of the universe from the big bang to the present, with an emphasis on the synergy between theory and observations. Topics will fall under three general headings: classical and relativistic cosmology, the early universe, and structure formation. (Prerequisites: ASTP-615 or equivalent course. Co-requisites: ASTP-750 or equivalent course.) Lecture 3, Credits 3 (Spring)

ASTP-889 Special Topics
This is a PhD-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This course requires permission of the Instructor to enroll.) Lecture, Credits 1 - 3

ASTP-890 Research and Thesis
Dissertation research by the candidate for an appropriate topic as arranged between the candidate and the research advisor. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 6 (Fall, Spring, Summer)

ASTP-891 Continuation of Thesis
Continuation of Thesis Continuation, Credits 0 (Fall, Spring, Summer)

ASTP-899 AST Independent Study
This course is a faculty-directed tutorial of appropriate topics that are not part of the formal curriculum. The level of study is appropriate for a PhD-level student. (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1 - 3

Biological Sciences

BIOL-601 Genetic Diseases and Disorders
The identification of genetic causes of disease has been one of the major modern scientific breakthroughs. This course examines a range of inherited diseases, how causative genetic variations were or are being identified, and what this means for the treatment of the diseases. Scientific literature will be utilized, both current and historical. (Prerequisites: BIOL-321 or equivalent course or graduate student standing.) Lecture 3, Credits 3 (Spring)

BIOL-625 Ethics in Bioinformatics
This course will be focused on individual and organizational responsibilities in bioinformatics research, product development, product commercialization and clinical and consumer genetic testing. (This course is restricted to students in the BIOINFO-MS program.) Lecture 3, Credits 3 (Fall, Spring)

BIOL-630 Bioinformatics Algorithms
Bioinformatics Resources will focus on the types of analyses, tools, and databases that are available and commonly used in Bioinformatics. The labs will apply the lecture material in the analysis of real data. (This course is restricted to students in the BIOINFO-MS program.) Lab 3, Lecture 2, Credits 3 (Fall)

BIOL-635 Bioinformatics Seminar
The course provides opportunities for students and faculty to develop and share professional interests while discussing current trends and developments in bioinformatics. Material for this course will be drawn from the current scientific literature. (This course is restricted to students in the BIOINFO-MS program.) Lecture 3, Credits 3 (Fall)

BIOL-650 High Throughput Sequencing Analysis
Students will utilize commonly used bioinformatics tools to analyze a real High Throughput Sequencing data set starting with raw data, proceeding with quality control, either aligning to a reference genome or performing de novo assembly, assessing differential gene expression determination, and finally annotating their results. Weekly lab meetings will be required, and a group manuscript is expected at the end of the semester. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lab 6, Lecture 1, Credits 3 (Fall)

BIOL-655 Biogeography
This course is the study of the distribution of biodiversity on the earth. Patterns of past and present animal and plant distributions are used to help understand the mechanisms of basic biological processes including speciation, dispersal, divergence and extinction. This course will cover the character and history of the science of biogeography, as well as its basic principles and applications. We will also examine the assumptions, methods and conclusions of historically significant biogeographic studies. (Prerequisites: BIOL-240 or BIOL-265 or graduate student standing in the ENVS-MS program.) Lecture 3, Credits 3 (Spring)

BIOL-671 Database Management for the Sciences
Students will learn to create and maintain efficient relational databases for use in modeling and analysis in the sciences. Topics will include an introduction to relational algebra, SQL, and advanced relational designs. (Graduate standing in COS or permission of instructor) (GRADS) Lab 3, Lecture 2, Credits 3 (Fall)

BIOL-673 Marine Biology
This course explores marine biology focusing on the diversity of life and influence of oceanographic phenomena on the various ecosystems. Morphological and physiological adaptations along with environmental threats will also be investigated. The course will explore marine conservation issues, in depth. (Prerequisites: BIOL-240 or equivalent course or graduate student standing in the ENVS-MS program.) Lecture 4, Credits 4 (Fall)

BIOL-675 Advanced Conservation Biology
This course focuses on the application of ecological principles to conservation issues. Human impact on species diversity will be emphasized as it relates to agricultural, forest, coastal and wetland ecosystems. Case studies of management practices used to manage and restore disturbed ecosystems will be included. Students will explore a topic in depth through writing a review paper of published literature. (Prerequisites: BIOL-240 or equivalent course or graduate student standing in the ENVS-MS program.) Lecture 3, Credits 3 (Spring)

BIOL-694 Molecular Modeling and Proteomics
This course will explore two facets of protein molecules: their structure and their expression. The structure component will build upon information from earlier bioinformatics courses. The course will also include the analysis of inter-molecular interactions, such as ligand/receptor pairing, by employing software that permits modeling of molecular docking experiments. Tissue-specific protein expression will be addressed in lectures with descriptions of microarray, SAGE, 2D gel electrophoresis and other contemporary technologies and in the laboratory through software commonly used to analyze and compare gene expression levels. Each student will be assigned a project designed to integrate salient principles covered in the course and provide an opportunity for each student to give an oral presentation to his or her peers. In addition, each student will write a paper describing a practical application of proteomics. (Prerequisites: BIOL-330 or equivalent course or graduate student standing.) Lab 3, Lecture 2, Credits 3 (Spring)

BIOL-700 Cell and Molecular Genetics
This course will introduce cellular and molecular biology to graduate students with limited background in the biological sciences. The approach to be taken is to bring students into the empirical data to support the basic concepts presented. Upon completion of this course students will not only be familiar with cellular and molecular biology but will also be acquainted with the theoretical foundations of modern laboratory techniques. Topics covered in this course include cellular evolution, small molecules, energy and biosynthesis, macromolecules, protein functions, genetics mechanisms, recombinant DNA technologies, the nucleus, regulation of gene expression, membrane structure and function, intracellular protein trafficking, energy conservation in mitochondria and chloroplasts, cell signaling, the cytoskeleton, the cell cycle, cell division, intercellular interactions, germ cells and development, cellular differentiation, immunity and cancer. (Prerequisites: BIOL-330 or equivalent course or graduate student standing in the ENVS-MS program.) Lecture 3, Credits 3 (Fall)

BIOL-789 Graduate Special Topics
This is a graduate course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. Lecture/Lab, Credits 1 - 4 (Fall, Spring, Summer)

BIOL-790 Research and Thesis
Masters-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. (This course requires permission of the Instructor to enroll.) Thesis, Credits 1 - 6 (Fall, Spring, Summer)
This course is designed to introduce the technical aspects of keeping a magnetic resonance system operating. The theory of operation of the magnet, radio frequency, pulse programmer, computer, and supporting subsystems of a magnetic resonance instrument will be studied. Emphasis is placed on relating theory to achievable practice and the consequences of differences between the two. Techniques for troubleshooting problems will be presented and developed. (Prerequisites: CHMA-725 and CHMP-747 and CHMA-740 or equivalent courses.) Lecture 3, Credits 3 (Fall)

**CHMA-750 NMR Spectrometer Maintenance**

An advanced study of the structure and function of proteins and enzymes. Biophysical and mechanistic aspects of enzyme function will be examined. Applications of computation to protein structure will also be discussed. (Prerequisites: CHMB-402 or equivalent course or degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Spring)

**CHEM-670 Graduate Chemistry Writing**

Cooperative work experience for graduate chemistry students. Credit 0 Co-op, Credits 0 (Fall, Spring, Summer)

**CHEM-699 Chemistry Graduate Co-op**

This is a master-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This course requires permission of the Instructor to enroll.) Lecture, Credits 1 - 3 (Fall, Summer)

**CHEM-780 Chemistry Project**

The theory, applications, and limitations of selected instrumental methods in qualitative, quantitative and structural analysis will be discussed. This course will also review and stress the importance of these components. (Prerequisite: Graduate standing in CHEM-MS.) Lecture 1, Credits 1 (Fall)

**CHEM-670 Graduate Chemistry Writing**

Research and Thesis

Dissertation research by the candidate for an appropriate topic as arranged between the candidate and the research advisor. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 6 (Fall, Spring, Summer)

**CHEM-791 Continuation of Thesis**

Independent Study, Credits 0

This course is a faculty-directed tutorial of appropriate topics that are not part of the formal curriculum. The level of study is appropriate for a masters-level student. (Enrollment in this course requires permission from the department offering the course.) Continuation of Thesis, Credits 1 - 3 (Fall, Summer)

**CHEM-799 Independent Study**

Advanced Instrumental Analysis Lab

This course presents the magnetic resonance family of techniques. General techniques include nuclear magnetic resonance (NMR), electron spin resonance (ESR), nuclear quadrupole resonance (NQR), and muon spin resonance (MSR). Each technique will be presented in enough detail to give the student an appreciation of its capabilities and an understanding of the theory of the spectroscopy. (Prerequisites: Graduate standing in CHEM-MS.) Lecture 3, Credits 3 (Fall)

**CHMA-725 The Magnetic Resonance Family**

This course analyzes protein structure-function relationships. Students will investigate how proteins function and how the structure relates to that function. The principles that explain enzyme rate enhancements and mechanistic enzymology will be examined. Additionally, protein superfamilies for phylogenetic relationships will be explored to enhance understanding of protein structure-function relationships. Students will read and discuss the current scientific literature and classic papers. (Prerequisites: CHMB-403 or equivalent course or Graduate Standing in CHEM-MS.) Lecture 3, Credits 3 (Spring)

**CHMB-702 Protein Conformation and Dynamics**

Continued study of the structure and function of proteins and enzymes. Biophysical and mechanistic aspects of enzyme function will be examined. Applications of computation to protein structure will also be discussed. (Prerequisites: CHMB-402 or equivalent course or degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Spring)

**CHMB-704 Biochemistry of Nucleic Acids**

Advanced Protein Biochemistry: Structure and Function

This course will revisit many of the reactions covered in the first year of organic chemistry with an emphasis on stereochemical control. Students will be introduced to the technique of retrosynthesis. The course will introduce more reactions with an emphasis on current topics from the literature. Students will hone their skills in writing electron pushing mechanisms and the use of protecting groups while practicing the art of designing synthetic strategies for making natural products. (Prerequisite: CHMO-232 or CHMO-332 with a grade of C- or better or equivalent course or Graduate Standing in CHEM-MS.) Lecture 3, Credits 3 (Fall)

**CHMO-637 Advanced Organic Chemistry**

Spectrometric Identification of Organic Compounds

This course will cover nucleic acid structures as determined by NMR and X-ray crystallography and nucleic acid catalysis, especially that of ribozymes. Genomics, specifically whole-genome sequencing papers, will be analyzed. Current DNA topics including the RNA World, Ribozymes, RNAi, and Riboswitches will be discussed. Current DNA topics including Lateral/Horizontal DNA Transfer, Genome Duplication, Alternate Gene Expression and Synthetic Life will also be discussed. (Prerequisites: CHMB-402 or equivalent course or degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Spring)

**CHMO-640 Mechanisms of Drug Interactions**

Modern Inorganic Chemistry

This course will investigate drug discovery, lead optimization, drug-receptor interactions, and bioavailability. Historically important drug classes and their mechanism of action will receive special consideration. (Prerequisites: CHMO-637 or equivalent course or Graduate Standing in CHEM-MS.) Lecture 3, Credits 3 (Spring)

**CHMO-710 Literature Exploration of Organic Synthesis**

This course will be a survey of the recent literature in organic chemistry with a focus on the chemistry concerning the synthesis of natural products and/or methodology towards synthesizing natural products. During each week of the course a student is selected to lead a discussion based on an article from a premier journal. This course may be repeated for credit. (Prerequisites: CHMO-637 or equivalent course.) Lecture 1, Credits 1 (Fall, Spring)
CHMO-739 Advanced Physical Organic Chemistry
This course covers topics in physical organic chemistry including: techniques for elucidation of mechanisms (kinetic, and linear free energy relationships); isotope effects; molecular orbital theory; and electrocyclic reactions. (Prerequisites: CHMO-332 and CHMP-441 or equivalent course or Graduate Standing in CHEM-MS.) Lecture 3, Credits 3 (Spring)

CHMP-747 Principles of Magnetic Resonance
This course is designed to present the theory of magnetic resonance from a physical chemistry perspective. Students will learn about isotropic and anisotropic proton-electron hyperfine, proton-electron dipolar, and proton-proton dipolar interactions; choosing basis functions and eigenfunctions for energy states; setting up the Hamiltonian; and solving for the energies of the states in both the rigid (solid) and rapidly tumbling (liquid) states. The dynamic nature of magnetic resonance will be developed from a kinetic perspective and focus on relaxation times, observable phenomena on the magnetic resonance timescale, and line broadening. Pulsed NMR will be presented from a classical perspective emphasizing spin packets, net magnetization, and rotation matrices through the Bloch equations. (Prerequisites: CHMP-442 or equivalent course or Graduate Standing in CHEM-MS.) Lecture 3, Credits 3 (Fall)

CHMP-751 Colloid and Interface Science
The parallel growth of nanotechnology and a molecular perspective in the medical and life sciences has focused attention on the colloidial domain structures of dimension 1 nm to 1 mm. This course will introduce colloid and interface science that will allow for an appreciation of the role of colloids in biological systems, industrial processes and commercial products. (Prerequisites: CHMP-441 or equivalent course or Graduate Standing in CHEM-MS.) Lecture 3, Credits 3 (Fall)

CHMP-752 Molecular Photophysics and Photochemistry
This course provides a comprehensive and clear description of the concepts and principles of molecular photophysical processes and photochemistry. The practical methods required for associated photophysical characterization and measurement are presented along with important applications of molecular photons in cutting-edge research. A review of quantum mechanics is given with the photophysicist in mind such that the student is encouraged to make more use of quantum mechanical terms, quantities and concepts. The course covers the interaction of light with molecular orbitals to form an excited state, and its subsequent deactivation. Applications such as lasers, spectroscopy, photoinduced charge transfer in modern organic photovoltaics and photosynthesis are described. (Prerequisites: CHMP-442 or equivalent course or Graduate Standing in CHEM-MS.) Lecture 3, Credits 3 (Spring)

CHMP-753 Computational Chemistry
This course will introduce students to an in-depth investigation into the computational theories and applications used to model complex physical and chemical phenomena. Computational methods are used to provide synergy linking experiment with theory involving such chemical processes as reaction mechanisms, docking, energy transfer and conformational conversions. Predicting spectral and thermodynamic properties of molecular systems and ensembles will also be treated. (Prerequisites: CHMP-442 or equivalent course or Graduate Standing in CHEM-MS.) Lecture 3, Credits 3 (Fall)

CHPO-706 Polymer Chemistry I
This course offers an in-depth survey of contemporary chemistry involved in the synthesis of high molecular weight polymers and macromolecules and the relationships between their structure and properties, and applications. The course focuses on fundamental principles that govern phase structure and statistics, solution behavior, and characterization of polymers. Specific attention is given to recent advances and current issues in the synthesis of polymers, and to controlled architectures and self-assembly of polymers and macromolecules. (Prerequisites: CHMO-332 and CHMP-441 or equivalent course or Graduate Standing in CHEM-MS.) Lecture 3, Credits 3 (Fall)

CHPO-707 Polymer Chemistry II
This course further investigates the contemporary chemistry of high molecular weight polymers and macromolecules and the relationships between their structure, functionality, and utility. The course focuses on fundamental principles that govern swollen gels and soft matter. Mechanisms of the formation of polymers containing heteroatoms in their chains are examined in detail. Specific attention is given to the synthesis of polymers of controlled architecture and self-assembly, and of polymers and macromolecules. Dendrimers, hyper-branched polymers, functional polymers, polymeric reagents, poly electrolytes, and biopolymers are also discussed. (Prerequisites: CHPO-706 or equivalent course.) Lecture 3, Credits 3 (Spring)

CHPO-708 Polymer Synthesis and Characterization Lab
Students will synthesize about eight polymers and characterize them by specific methods. In about half of those experiments step-growth polymerizations and in the other half chain-addition polymerizations will be performed. Among the polymers produced will be Nylon-6,10, Nylon 11, polystyrene, high-density polyethylene, linear low-density polyethylene, copolymer of styrene and methyl methacrylate and polyurethane. The most specific types of polymerizations and reactions introduced will be cross-linking polymer, interfacial and bulk step-growth polymerizations, cyclopolymerization, radical, ionic and coordinative chain polymerizations. The methods of characterization which will be applied are infrared (IR) and nuclear magnetic resonance (NMR) spectroscopy, titrations, thermal gravimetric analysis (TGA), differential scanning calorimetry (DSC), measurement of swelling, and viscometry. (Prerequisites: CHMO-336 or equivalent course or Graduate Standing in CHEM-MS.) Lab 8, Credits 3 (Fall)

CLRS-601 Principles of Color Science
This course covers the principles of color science including theory, application, and hands-on experience incorporated into the lectures. Topics include color appearance (hue, lightness, brightness, chroma, saturation, colorfulness), colorimetry (spectral, XYZ, xyY, L*ab, L*chab, DEab, DE00), the use of linear algebra in color science and color imaging, metamericism, chromatic adaptation, color inconstancy, color rendering, color appearance models (CIECAM02), and image appearance models (S-CIELAB, ICAM). (Prerequisites: Graduate standing in CLRS-MS, IMGS-MS, CLRS-PHD or IMGS-PHD.) Lecture 3, Credits 3 (Fall)

CLRS-602 Color Physics and Applications
This course explores the relationship between a material’s color and its constituent raw materials such as colorants, binding media, substrates, and overcoats. These can be determined using a variety of physical models based on absorption, scattering, luminescence, and interference phenomena. These models enable the production of paints, plastics, colored paper, printing, and others to have specific colors. Accompanying laboratories will implement and optimize these models using filters, artist opaque and translucent paints and varnishes including metallic and pearlescent colorants, and inkjet printing. Statistical techniques include principal component analysis and linear and nonlinear optimization. (Prerequisites: Graduate standing in CLRS-MS, IMGS-MS, CLRS-PHD or IMGS-PHD.) Lecture 3, Credits 3 (Fall)

CLRS-699 Color Science Graduate Co-op
Cooperative work experience for graduate color science students. Co-op, Credits 0 (Fall, Spring, Summer)

CLRS-720 Computational Vision Science
Computational Vision Science This course provides an introduction to modern computer-based methods for the measurement and modeling of human vision. Lectures will introduce the experimental techniques of visual psychophysics including threshold measurement, psychometric functions, signal detection theory, and indirect, direct, and multidimensional scaling. Lectures will also introduce the MATLAB technical computing environment and will teach how to use MATLAB to run computer-based psychophysical experiments and to analyze experimental data and visualize results. Laboratory exercises will provide practical experience in using computer-based tools to conduct psychophysical experiments and to develop computational models of the results. Prior experience in vision science and/or scientific computing will be helpful but is not required. (Prerequisites: Graduate standing in CLRS-MS, IMGS-MS, CLRS-PHD or IMGS-PHD.) Lecture 3, Credits 3 (Fall)

CLRS-750 Historical Research Perspectives
Historical Research Perspectives is a weekly forum in which students will learn about histori- cal and classic topics in color science. The course focuses on journal club discussions of papers selected by the students and faculty. It also includes oral presentations from students, laboratory staff, and faculty as well as visiting speakers from within and external to RIT. Students will prepare their own oral presentations and written assignments based on the course readings and independent research. Students will develop professional skills required for formal scientific presentations and writing. (This course requires permission of the Instructor to enroll.) Seminar 1, Credits 1 (Fall)

CLRS-751 Research and Publication Methods
Color Science Seminar II is a weekly forum in which students will learn about current research topics in color science. The course focuses on journal club discussions of papers selected by the students and faculty. It also includes oral presentations from students, laboratory staff, and faculty as well as visiting speakers from within and external to RIT. Students will prepare their own oral presentations and written assignments based on the course readings and independent research. Students will further develop professional skills required for formal scientific presentations and writing. A draft thesis or dissertation proposal will also be prepared. (Prerequisites: CLRS-750 or equivalent course CLRS-750 Prereq) Seminar 2, Credits 2 (Spring)
Graduate Course Descriptions

College of Science

**ENVS-795 Environmental Science Graduate Research**
This course is a graduate level, faculty-directed, student project or research involving labora-
tory or field work, computer modeling, or theoretical calculations that could be considered
of an original nature. The level of study is appropriate for students in Environmental Science
graduate program. **Thesis, Credits 1 - 4 (Fall, Spring, Summer)**

**ENVS-798 Advanced Environmental Science Independent Study**
This course is a faculty-directed tutorial of appropriate topics that are not part of the formal
curriculum. The level of study is appropriate for student in the Environmental Science gradu-
ate program. **Enrollment in this course requires permission from the department offering the
course. Independent Study, Credits 1 - 4 (Fall, Spring, Summer)**

**Imaging Science**

**IMGS-606 Graduate Seminar I**
This course is focused on familiarizing students with research activities in the Carlson Center,
research practices in the university, research environment and policies and procedures impact-
ing graduate students. The course is coupled with the research seminar sponsored by the Center
for Imaging Science (usually weekly presentations). Students are expected to attend and par-
ticipate in the seminar as part of the course. The course also addresses issues and practices
associated with technical presentation and technical writing. Credits earned in this course
apply to research requirements. **(This class is restricted to graduate students in the IMGS-MS
and IMGS-PHD programs.) Seminar 1, Credits 1 (Fall)**

**IMGS-607 Graduate Seminar II**
This course is a continuation of the topics addressed in the preceding course Imaging Science
Graduate Seminar I. The course is coupled with the research seminar sponsored by the Center
for Imaging Science (usually weekly presentations). Students are expected to attend and partici-
pate in the seminar as part of the course. The course addresses issues and practices associated
with technical presentations. Credits earned in this course apply to research requirements.
**(Prerequisites: IMGS-606 or equivalent course.) Seminar 1, Credits 1 (Spring)**

**IMGS-609 Graduate Laboratory I**
This laboratory course is intended to familiarize students with the concepts considered in the
required Radiometry course. Students work with a variety of radiometry hardware in a labo-
atory to perform measurements and experiments in topics such as radiation detection and
propagation, source and instrument calibration, and calibration and use of a camera as a radi-
ometer. **(Prerequisites: Graduate standing in the IMGS-MS program. Co-Requisites: IMGS-619
or equivalent course.) Lab 3, Credits 1 (Fall)**

**IMGS-610 Graduate Laboratory II**
This laboratory course is intended to familiarize students with the concepts considered in the
required Optics and Digital Image Processing courses. Students work with a variety of optical
hardware in a laboratory to perform measurements and experiments in topics such as ray trac-
ing, diffraction, optical filtering, polarization, interferometry, and holography. **(Co-requisi-
tes: IMGS-633 and IMGS-682 or equivalent courses.) Lab 3, Credits 1 (Spring)**

**IMGS-613 Probability, Noise, and System Modeling**
This course develops models of noise and random processes within the context of imaging
systems. The focus will be on stationary random processes in both one dimension (time) and
two dimensions (spatial). Power spectrum estimation will be developed and applied to signal
characterization in the frequency domain. The effect of linear filtering will be modeled and
applied to signal detection and maximization of SNR. The matched filter and the Wiener fil-
ter will be developed. Signal detection and amplification will be modeled, using noise figure
and SNR as measures of system quality. At completion of the course, the student should have
the ability to model signals and noise within imaging systems. **(Prerequisites: IMGS-616 and
IMGS-619 or equivalent courses.) Lecture 3, Credits 3 (Fall)**

**IMGS-616 Fourier Methods for Imaging**
This course develops the mathematical methods required to describe continuous and discrete
linear systems, with special emphasis on tasks required in the analysis or synthesis of imaging
systems. The classification of systems as linear/nonlinear and shift variant/invariant, develop-
ment and use of the convolution integral, Fourier methods as applied to the analysis of linear
systems. The physical meaning and interpretation of transform methods are emphasized.
**(This class is restricted to graduate students in the IMGS-MS and IMGS-PHD programs.)
Lecture 3, Credits 3 (Fall)**

**IMGS-619 Radiometry**
This course is focused on the fundamentals of radiation propagation as it relates to making
quantitative measurements with imaging systems. The course includes an introduction to com-
mon radiometric terms and derivation of governing equations with an emphasis on radiation
propagation in both non-intervening and turbid media. The course also includes an introduc-
tion to detector figures of merit and noise concepts. **(This class is restricted to graduate students
in the IMGS-MS and IMGS-PHD programs.) Lecture 3, Credits 3 (Fall)**
College of Science

IMGS-628 Design and Fabrication of Solid State Camera
The purpose of this course is to provide the student with hands-on experience in building a CCD camera. The course provides the basics of CCD operation including an overview, CCD clocking, analog output circuitry, cooling, and evaluation criteria. (This class is restricted to graduate students in the IMGS-MS and IMGS-PHD programs.) Lab 6, Lecture 1, Credits 3 (Fall)

IMGS-672 Multi-view Imaging
Images are 2D projections gathered from scenes by perspective projection. By making use of multiple images it is possible to construct 3D models of the scene geometry and of objects in the scene. The ability to derive representations of 3D scenes from 2D observations is a fundamental requirement for applications in robotics, intelligence, medicine and computer graphics. This course develops the mathematical and computational approaches to modeling of 3D scenes from multiple 2D views. After completion of this course students are prepared to use the techniques in independent research. (Prerequisites: IMGS-616 or IMGS-682 or equivalent course.) Lecture 3, Credits 3 (Spring)

IMGS-682 Advanced Environmental Applications of Remote Sensing
This course will focus on a broader selection of analytical techniques with an application-centric presentation. These techniques include narrow-band indices, filtering in the spatial and frequency domains, principal component analysis, textural analysis, hybrid and object-oriented classifiers, change detection methods, and structural analysis. All of these techniques are applied to assessment of natural resources. Sensing modalities include imaging spectroscopy (hyperspectral), multispectral, and light detection and ranging (lidar) sensors. Applications such as vegetation stress assessment, foliar biochemistry, advanced image classification for land use purposes, detecting change between image scenes, and assessing topography and structure in forestry and grassland ecosystems (volume, biomass, biodiversity) and built environments will be examined. Real-world remote sensing and field data from international, US, and local sources are used throughout this course. Students will be expected to perform a more comprehensive final project and homework assignments, including literature review and discussion and interpretation of results. (This course requires permission of the Instructor to enroll.) Lab 3, Lecture 2, Credits 3 (Spring)

IMGS-699 Imaging Science Graduate Co-op
This course is a cooperative education experience for graduate imaging science students. (Enrollment in this course requires permission from the department offering the course.) Co-op, Credits 0 (Fall, Spring, Summer)

IMGS-712 Computational Methods for Imaging Science
This course addresses computational topics that are important in a variety of applications in imaging science. Examples of topics that may be included are: vector space operations, including matrix factorizations and solutions of systems of equations (used in hyperspectral target detection and image compression, among many other applications); linear and nonlinear optimization (used for the design of detectors, camera calibration, bundle adjustment, etc.); iterative methods and dynamic systems (Kalman filtering, tracking, optical flow, etc.); random number generation and use (Monte Carlo methods, system performance evaluation, etc.); and energy minimization techniques applied to image processing (used for image enhancement, segmentation, etc.) (Prerequisites: IMGS-616 or IMGS-682 or equivalent course.) Lecture 3, Credits 3 (Fall)

IMGS-715 Computational Photography
Computational photography is an emerging field that aims to overcome the limitations of conventional digital imaging and display devices by using computational techniques and novel programmable sensors and optical devices. In this course, we will study start-of-the-art techniques for capturing, modeling, and displaying complex appearance phenomena. We will cover topics such as computational sensor with assorted pixel designs, mobile camera control, light field capture and rendering, computational flash photography, computational illumination for appearance modeling and 3D reconstruction, light transport analysis, and light sensitive display and printing techniques. We will integrate the latest smart imaging devices into the course for homework and term projects. (This course is restricted to students with graduate standing in the College of Science or the Kate Gleason College of Engineering.) Lecture 3, Credits 3 (Fall)

IMGS-723 Introduction to Electron Microscopy
This course introduces the basic concepts and practice of electron microscopy, including transmission electron microscopy (TEM), scanning electron microscopy (SEM) and x-ray microanalysis. During the second half of the course students will do an 8-10 hour hands-on project in SEM or TEM or both, including a project paper and a poster presentation. Laboratory demonstrations will be held in the Nanolab imaging Lab to reinforce the lecture material. (This course is restricted to students with graduate standing in the College of Science or the Kate Gleason College of Engineering.) Lecture 3, Credits 3 (Spring)

IMGS-724 Magnetic Resonance Imaging
This course is designed to teach the principles of the imaging technique called magnetic resonance imaging (MRI). The course covers spin physics, Fourier transforms, basic imaging principles, Fourier imaging, imaging hardware, imaging techniques, image processing, image artifacts, safety, and advanced imaging techniques. (This class is restricted to graduate students in the IMGS-MS and IMGS-PHD programs.) Lecture 3, Credits 3 (Spring)

IMGS-731 Ultrasound Imaging
This course is an overview of the physics and signal processing principles of ultrasound as applied to different medical imaging modalities such as B-mode, M-mode, Doppler, and 3D imaging. Tissue characterization methods are introduced. (Prerequisites: IMGS-616 and IMGS-682 or equivalent courses.) Lecture 3, Credits 3 (Spring)

IMGS-733 Medical Imaging Systems
This course is an introduction to the physics, instrumentation, and signal processing methods used in different imaging modalities such as X-ray CT, MRI, PET/SPECT and ultrasound. (Prerequisites: IMGS-616 and IMGS-682 or equivalent courses.) Lecture 3, Credits 3 (Fall)

IMGS-737 Physical Optics
This course covers the wave properties of light, its interaction with matter, and the application of these principles to imaging systems. Topics include polarization of light, birefringence, interference and interferometers, spatial and temporal coherence, and scalar diffraction theory. (Co-requisites: IMGS-635 or equivalent course.) Lab 3, Lecture 2, Credits 3 (Spring)

IMGS-740 Imaging Science MS Systems Project Paper
The analysis and solution of imaging science systems problems for students enrolled in the MS Project capstone paper option. Research 3, Credits 3 (Fall, Spring, Summer)
Materials Science and Engineering

MTSE-601 Materials Science
This course provides an understanding of the relationship between structure and properties necessary for the development of new materials. Topics include atomic and crystal structure, crystalline defects, diffusion, theories, strengthening mechanisms, ferrous alloys, cast irons, structure of ceramics and polymeric materials and corrosion principles. Term paper on materials topic. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall)

MTSE-617 Material Degradation
This course introduces the basic electrochemical nature of corrosion and considers the various factors that influence the rate of corrosion in a variety of environments. Various means of controlling corrosion are considered with demonstrations. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall)

MTSE-660 Plasma Science
This course is an introduction to plasma science. Phenomena and application of plasma torching, deposition, polymerization, plasma production of materials, and atmospheric science will be discussed. Various methods for plasma surface modification of materials with relevance to adhesion and characterization will also be covered. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Spring)

MTSE-699 Materials Science Graduate Co-op
This course is a cooperative education experience for materials science and engineering masters-level students. Co-op, Credits 0 (Fall, Spring, Summer)

MTSE-702 Polymer Science
This course is an introduction to the chemistry and physics of synthetic polymers, which include plastics, elastomers and fibers. The synthesis of polymers, their fundamental properties, and the relations between their syntheses, structure, and properties will be studied. Among the topics discussed are the morphology, thermal behavior, solubility, viscoelasticity and characterization of polymers. Copolymerization, tacticity and sustainability of polymers will also be covered. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Spring)

MTSE-703 Solid State Science
This course provides a survey of topics in the physics of solids. It will include crystal symmetry, structure and binding. It will also address the mechanical, thermal, and electrical properties of insulators, semiconductors, and conductors as well as band theory. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Spring)

MTSE-704 Theoretical Methods in Materials Science and Engineering
This course includes the treatment of vector analysis, special functions, waves, and fields; Maxwell Boltzmann, Bose-Einstein and Fermi-Dirac distributions, and their applications. Selected topics of interest in electrodynamics, fluid mechanics, and statistical mechanics will also be discussed. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall)

MTSE-705 Experimental Techniques
The course will introduce the students to laboratory equipment for hardness testing, impact testing, tensile testing, X-ray diffraction, SEM, and thermal treatment of metallic materials. Experiments illustrating the characterization of high molecular weight organic polymers will be performed. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lab 3, Credits 3 (Spring)

MTSE-777 Graduate Project
This course is a capstone project using research facilities available inside or outside of RIT. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 1 - 4

MTSE-780 Theory of Microsensors and Actuators
This course introduces the theory and development of sensors at the molecular and ionic levels. Mechanism details for operation of the sensors and actuators will be discussed. Fundamental aspects related to chemical, biochemical, piezoresistive, magnetic, thermal, and luminescent sensors will be discussed with an emphasis on the development of innovative products. Control systems based on ion selectivity for biomedical applications will be covered in detail. Neurotransmitters, neural network, and direction selective using conducting polymers will also be covered. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Spring)
Lecture 3, Credits 3 (Fall, Spring)

This course is a master-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This course requires permission of the Instructor to enroll.) Lecture, Credits 1 - 4 (Fall, Spring)

MATH-790 Research and Thesis

Dissertation research by the candidate for an appropriate topic as arranged between the candidate and the research advisor. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 9 (Fall, Spring, Summer)

MATH-792 External Research

Research conducted off-campus by the candidate for an appropriate topic as arranged between the student, the RIT advisor, and the off-campus research mentor. (Enrollment in this course requires permission from the department offering the course.) Research, Credits 1 - 4 (Fall, Spring, Summer)

MATH-793 Continuation of Thesis

Continuation of Thesis Continuation, Credits 0 (Fall, Spring)

MATH-799 Independent Study

This course is a faculty-directed tutorial of appropriate topics that are not part of the formal curriculum. The level of study is appropriate for a masters-level student. (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1 - 4 (Fall, Spring, Summer)

Mathematics

MATH-601 Methods of Applied Mathematics

This course is an introduction to classical techniques used in applied mathematics. Models arising in physics and engineering are introduced. Topical topics include dimensional analysis, scaling techniques, regular and singular perturbation theory, and calculus of variations. (Prerequisites: MATH-220 or MATH-221 and MATH-231 or equivalent courses or graduate standing in the ACMTH-MS program.) Lecture 3, Credits 3 (Spring)

MATH-603 Optimization Theory

This course provides a study of the theory of optimization of linear and nonlinear functions of several variables with or without constraints. The theory is applied to solve problems in business, management, engineering, and the sciences. Algorithms for practical applications will be analyzed and implemented. Students taking this course will be expected to complete applied projects and/or case studies. (Prerequisites: MATH-601 or equivalent course.) Lecture 3, Credits 3 (Spring)

MATH-605 Stochastic Processes

This course is an introduction to stochastic processes especially those that appear in various applications. It covered basic properties and applications of Poisson processes, and Markov chains in discrete and continuous time. (Prerequisites: MATH-241 and MATH-251 or equivalent courses or graduate standing in the ACMTH-MS program.) Lecture 3, Credits 3 (Spring)

MATH-606 Graduate Seminar I

The course prepares students to engage in activities necessary for independent mathematical research and introduces students to a broad range of active interdisciplinary programs related to applied mathematics. Lecture 2, Credits 1 (Fall)

MATH-607 Graduate Seminar II

This course is a continuation of Graduate Seminar 1. It prepares students to engage in activities necessary for independent mathematical research and introduces them to a broad range of active interdisciplinary programs related to applied mathematics. (Prerequisite: MATH-606 or equivalent course.) Lecture 2, Credits 1 (Spring)

MATH-611 Numerical Analysis

This course covers numerical techniques for the solution of nonlinear equations, interpolation, differentiation, integration, and solution of initial value problems. (Prerequisites: MATH-231 and MATH 241 or equivalent courses or graduate standing in the ACMTH-MS program.) Lecture 3, Credits 3 (Fall)

MATH-612 Numerical Linear Algebra

This course covers numerical techniques for the solution of systems of linear equations, eigenvalue problems, singular-values and other decompositions, applications to least squares, boundary value problems, and additional topics at the discretion of the instructor. (Prerequisites: MATH-611 or equivalent course.) Lecture 3, Credits 3 (Spring)

MATH-631 Dynamical Systems

This course is a study of dynamical systems theory. Basic definitions of dynamical systems are followed by a study of maps and time series. Stability theory of solutions of differential equations is studied. Asymptotic behavior of solutions is investigated through limit sets, attractors, Poincare-Bendixson theory, and index theory. The notion of local bifurcation is introduced and investigated. Chaotic systems are studied. (Prerequisites: MATH-231 and MATH 241 or equivalent courses or graduate standing in the ACMTH-MS program.) Lecture 3, Credits 3 (Fall)

MATH-641 Logic, Set Theory, and Computability

This course studies Peano axioms for the natural numbers, induction principles, and recursive definitions. The topics in set theory include axiomatic set theory and the Cantor-Bernstein theorem. The topics in logic are propositional logic and First-order logic. The section on computability covers formulation of the family of the computable functions and a discussion of the halting problem. (ACMTH-MS) Lecture 3, Credits 3 (Spring)

MATH-645 Graph Theory

This course introduces the fundamental concepts of graph theory. Topics to be studied include graph isomorphism, trees, network flows, connectivity in graphs, matchings, graph colorings, and planar graphs. Applications such as traffic routing and scheduling problems will be considered. Lecture 3, Credits 3 (Fall)

MATH-646 Combinatorics

This course introduces the fundamental concepts of combinatorics. Topics to be studied include counting techniques, binomial coefficients, generating functions, partitions, the inclusion-exclusion principle and partition theory. Lecture 3, Credits 3 (Spring)

MATH-655 Biostatistics

This course is an introduction to the probabilistic models and statistical techniques used in the analysis of biological and medical data. Topics include univariate and multivariate summary techniques, one and two sample parametric and nonparametric inference, censoring, and two way analysis of variance, and multiple and logistic regression analysis. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Fall)

MATH-671 Number Theory

This course is an introduction to the standard results and techniques of number theory. Topics include divisibility, congruences, Diophantine equations, Mobius inversion, quadratic reciprocity, and primitive roots. Cryptography and other applications will be discussed. Projects may be required. (ACMTH-MS) Lecture 3, Credits 3 (Fall)

MATH-695 Statistical Models for Bioinformatics

This course will investigate some of the statistical models that have proved useful in analyzing biological information. Examples include Markov models, such as the Jukes-Cantor and Kimura evolutionary models and hidden Markov models, and multivariate models used for discrimination and classification. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture 3, Credits 3 (Spring)

MATH-699 Math and Stats Graduate Co-op

This course is a cooperative education experience for graduate math and stats students. Co-op, Credits 0 (Fall, Spring, Summer)

MATH-711 Advanced Methods in Scientific Computing

This course examines the use of discrete Fourier transforms, simulation methods, optimization techniques, and number theory algorithms that are employed in modern scientific computing. (Prerequisites: MATH-611 or equivalent course.) Lecture 3, Credits 3 (Fall)

MATH-712 Numerical Methods for Partial Differential Equations

This is an advanced course in numerical methods that introduces students to computational techniques for solving partial differential equations, especially those arising in applications. Topics include: finite difference methods for hyperbolic, parabolic, and elliptic partial differential equations, consistency, stability and convergence of finite difference schemes. (Prerequisites: MATH-611 or equivalent course.) Lecture 3, Credits 3 (Fall)

MATH-735 Mathematics of Finance I

This course is an introduction to the mathematical concepts of finance. It covers models for pricing, interest and present value, and ARCH and GARCH time series techniques. The course is mathematical in nature and assumes a background in calculus (including Taylor series), linear algebra and basic probability. Other mathematical concepts and numerical methods are introduced as needed. Lecture 3, Credits 3 (Fall)
Mathematics of Finance II

This is the second course in a sequence that examines mathematical and statistical models in finance. By taking a mathematical viewpoint the course provides students with a comprehensive understanding of the assumptions and limitations of the quantitative models used in finance. Topics include delta hedging, introduction to Ito calculus, interest rate models and Monte Carlo simulations. The course is mathematical in nature and assumes a background in calculus (including Taylor series), linear algebra and basic probability. Other mathematical concepts and numerical methods are introduced as needed. Lecture 3, Credits 3 (Spring)

Partial Differential Equations II

This is a continuation of Partial Differential Equations I and deals with advanced methods for solving partial differential equations arising in physics and engineering problems. Topics to be covered include second order equations, Cauchy-Kovalevskaya theorem, the method of descent, spherical means, Duhamels principle, and Greens function in higher dimensions. (Prerequisites: MATH-741 or equivalent course.) Lecture 3, Credits 3 (Spring)

Mathematical Biology

This course introduces areas of biological sciences in which mathematics can be used to capture essential interactions within a system. Different modeling approaches to various biological and physiological phenomena are developed (e.g., population and cell growth, spread of disease, epidemiology, biological fluid dynamics, nutrient transport, biochemical reactions, tumor growth, genetics). The emphasis is on the use of mathematics to unify related concepts. (Prerequisites: MATH-601 or equivalent course.) Lecture 3, Credits 3 (Spring)

Mathematics of Cryptography

This course is an introduction to the mathematical problems and techniques that serve as a foundation for modern cryptosystems. The topics include: classical cryptosystems computational number theory, primality tests, finite fields, private and public key encryption schemes (RSA, ElGamal), and applications such as digital signatures, one way functions, and zero knowledge proofs. Use of elliptic curves in cryptography will also be covered. (Prerequisites: MATH-371 or MATH-671 or equivalent course. MATH-371 or MATH-671) Lecture 3, Credits 3 (Fall)

Wavlets and Applications

A mathematical introduction to the theory and applications of orthogonal wavelets and their use in analyzing functions and function spaces. Topics include a brief survey of Fourier series representation of functions, Fourier transform and the Fast Fourier Transform (FFT) before proceeding to the Haar wavelet system, multiresolution analysis, decomposition and reconstruction of functions, Daubechies wavelet construction, and other wavelet systems. Applications such as data compression, noise reduction and image processing will be studied. (Prerequisites: MATH-611 or equivalent course.) Lecture 3, Credits 3 (Fall)

Special Topics

This is a master-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) Lecture, Credits 1 - 6

Research and Thesis

Masters-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 0 - 9 (Fall, Spring, Summer)

Continuation of Thesis

Continuation of Thesis Continuation, Credits 0

Mathematical Graduate Independent Study

Independent Study (This course requires permission of the Instructor to enroll.) Independent Study, Credits 1 - 3 (Fall, Spring, Summer)

Classical Electrodynamics II

This course is an advanced treatment of electrodynamics and radiation. Classical scattering theory including Mie scattering, Rayleigh scattering, and the Born approximation will be covered. Relativistic electrodynamics will be applied to charged particles in electromagnetic fields and magnetohydrodynamics. (Prerequisites: PHYS-611 or equivalent course.) Lecture 3, Credits 3 (Spring)

Graduate Special Topics

This is a graduate course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. Lecture/Lab 3, Credits 1 - 3 (Fall, Spring, Summer)

Statistics

This is an introduction to two statistical-software packages, SAS and R, which are often used in professional practice. Some comparisons with other statistical-software packages will also be made. Topics include: data structures; reading and writing data; data manipulation, subsetting, reshaping, sorting, and merging; conditional execution and looping; built-in functions; creation of new functions or macros; graphics; matrices and arrays; simulations; select statistical applications. (Prerequisites: STAT-205 or MATH-252 or CQAS-252 or STAT-252 or graduate standing in the APPSTAT-MS or STATQL-ACI or SMIPPI-ACI program.) Lecture, Credits 3 (Fall, Spring)

Principles of Applied Statistics

Review of fundamental probability theory; review of key distributions in statistics; probability plotting; linear combinations of random variables; hypothesis testing; confidence intervals and other statistical intervals; use of simulations; importance of assumptions; multiple comparisons; goodness-of-fit tests. This course does not count as credit toward either the CQAS advanced certificates or MS degree. (Prerequisite: MATH-173 or MATH-182 or MATH-182A or equivalent course.) Lecture, Credits 2 (Summer)

Statistical Quality Control

A practical course designed to provide in-depth understanding of the principles and practices of statistical process control, process capability, and acceptance sampling. Topics include: statistical concepts relating to processes, Shewhart charts for attribute and variables data, CUSUM charts, EWMA charts, process capability studies, attribute and variables acceptance sampling techniques. (Prerequisites: STAT-145 or STAT-205 or MATH-252 or CQAS-252 or STAT-252 or graduate standing in the APPSTAT-MS or STATQL-ACI or SMIPPI-ACI program.) Lecture, Credits 3 (Fall, Spring)

Designing Experiments for Engineering and Sciences

How to design and analyze experiments, with an emphasis on applications in engineering and the physical sciences. Topics include the role of statistics in scientific experimentation; general principles of design, including randomization, replication, and blocking; replicated and un-replicated two-level factorial designs; two-level fractional-factorial designs; response surface designs. (Prerequisites: STAT-621 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

Survey Design and Analysis

This course is an introduction to sample survey design with emphasis on practical aspects of survey methodology. Topics include: survey planning, sample design and selection, survey instrument design, data collection methods, and analysis and reporting. Application areas discussed will include program evaluation, opinion polling, customer satisfaction, product and service design, and evaluating marketing effectiveness. Data collection methods to be discussed will include face-to-face, mail, Internet and telephone. (Prerequisites: STAT-145 or STAT-205 or MATH-252 or CQAS-252 or STAT-252 or permission of the instructor.) Lecture, Credits 3 (Summer)

Foundations of Experimental Design

This course is an introduction to experimental design with emphasis on both foundational and practical aspects. Topics include the role of statistics in scientific experimentation, completely randomized designs, randomized complete block designs, Latin square designs, incomplete block designs, nested designs, general factorial designs, split-plot designs, two-level fractional factorial designs, and response-surface methodology. (Prerequisites: STAT-205 or MATH-252 or CQAS-252 or STAT-252) and (CQAS-741 or STAT-741 or STAT-305) or equivalent course. Corequisites: CQAS-511 or STAT-511 or CQAS-611 or STAT-611 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

Mathematics for Statistics

This is a survey of the mathematical tools of some of the more mathematically rigorous statistics courses of the MS program. The topics include partial and higher-order differentiation, various methods of integration, the gamma and beta functions, and a brief overview of linear algebra, all in the context of application to statistics. (Prerequisite: MATH-173 or MATH-182 or MATH-182A or equivalent course.) Lecture, Credits 2 (Summer)

Theory of Statistics I

This course introduces the student to the fundamental principles of statistical theory while laying the groundwork for study in the course sequel and future reading. Topics include classical probability, probability mass/density functions, mathematical expectation (including moment-generating functions), special discrete and continuous distributions, and distributions of functions of random variables. (Prerequisites: MATH-173 or MATH-182) and (STAT-205 or MATH-252 or CQAS-252 or STAT-252) or graduate standing in the APPSTAT-MS or APPSTAT-BS/MS or STATQL-ACI or SMIPPI-ACI program or permission of the instructor.) Lecture, Credits 3 (Fall, Spring)
STAT-722  Theory of Statistics II
Building on foundations laid in the first course, this second course in statistical theory answers some of the “How?” and “Why?” questions of statistics. Topics include the sampling distributions and the theory and application of point and interval estimation and hypothesis testing. (Prerequisites: CQAS-721 or STAT-721 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

STAT-731  Fundamentals of Statistical Theory
This course introduces the students to the fundamental principles of modern graduate level statistical theory with a strong emphasis on conceptual aspects of estimation theory and statistical inference along with an exploration of the modern computational techniques needed in the application/implementation of the methods covered. Topics include fundamentals of probability theory for statistics, random variable with a focus on the understanding and use of probability distribution function (both probability density function and cumulative distribution function), quantities of a distribution, understanding and use of the mathematical expectation operator, special discrete and continuous distributions, and distributions of functions of random variables and their use in statistical modelling, sums of random variables as used in statistics, point estimation, limit theorems, properties of estimators (bias, variance, mean squared error, consistency, efficiency, sufficiency), bias variance trade-off, interval estimation, hypothesis testing, bootstrap approach to estimation and inference, and elements of computational statistics. (This course is restricted to APPSAT-MS or SMPPI-ACT Major students.) Lecture 3, Credits 3 (Fall, Spring)

STAT-747  Principles of Statistical Data Mining
This course covers topics such as clustering, classification and regression trees, multiple linear regression under various conditions, logistic regression, PCA and kernel PCA, model-based clustering via mixture of gaussians, spectral clustering, test mining, neural networks, support vector machines, multidimensional scaling, variable selection, model selection, k-means clustering, k-nearest neighbors classifiers, statistical tools for modern machine learning and data mining, naïve Bayes classifiers, variance reduction methods (bagging) and ensemble methods for predictive optimality. (Prerequisites: STAT-611 and STAT-741 or equivalent course.) Lecture, Credits 3 (Spring)

STAT-753  Nonparametric Statistics and Bootstrapping
The emphasis of this course is how to make valid statistical inference in situations when the typical parametric assumptions no longer hold, with an emphasis on applications. This includes certain analyses based on rank and/or ordinal data and resampling (bootstrapping) techniques. The course provides a review of hypothesis testing and confidence-interval construction. Topics based on ranks or ordinal data include: sign and Wilcoxon signed-rank tests, Mann-Whitney and Friedman tests, runs tests, chi-square tests, rank correlation, rank order tests, Kolmogorov-Smirnov statistics. Topics based on bootstrapping include: estimating bias and variability, confidence interval methods and tests of hypothesis. (Prerequisites: STAT-205 or MATH-252 or STAT-252 or equivalent course.) Lecture, Credits 3 (Summer)

STAT-756  Multivariate Analysis
Multivariate data are characterized by multiple responses. This course concentrates on the mathematical and statistical theory that underlies the analysis of multivariate data. Some important applied methods are covered. Topics include matrix algebra, the multivariate normal model, multivariate t-tests, repeated measures, MANOVA principal components, factor analysis, clustering, and discriminant analysis. (Prerequisites: MATH-241, (CQAS-721 or STAT-731) and (CQAS-511 or STAT-511 or STAT-611) or equivalent courses.) Lecture, Credits 3 (Fall, Spring)

STAT-757  Design and Analysis of Clinical Trials
This is a graduate level survey course that stresses the concepts of statistical design and analysis for clinical trials. Topics include the design, implementation, and analysis of trials, including treatment allocation and randomization, factorial designs, cross-over designs, sample size power, reporting and publishing, etc. SAS for Windows statistical software will be used throughout the course for data analysis. (Prerequisites: STAT-205 or MATH-252 or CQAS-252 or STAT-252 or graduate standing in APPSTAT-MS or STATQL-Act or SMPPI-Act.) Lecture, Credits 3 (Fall, Spring)

STAT-762  SAS Database Programming
This course is designed to provide the student with a solid practical hands-on introduction to the fundamentals of time series analysis and forecasting. Topics include stationarity, filtering, differencing, time series decomposition, time series regression, exponential smoothing, and Box-Jenkins techniques. Within each of these we will discuss seasonal and nonseasonal models. (Prerequisites: CQAS-741 or STAT-741 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

STAT-763  SAS Programming
This course focuses on the SAS programming language to read data, create and manipulate SAS data sets, using Structured Query Language (SQL), creating SAS macros, and SAS programming efficiency. This course covers the material required for "SAS Base Programming" and "SAS Advanced Programming," certification exams. (Prerequisites: CQAS-511 or STAT-511 or CQAS-611 or STAT-611 or STAT-711 or equivalent course.) Lecture, Credits 3 (Fall, Spring)

STAT-773  Time Series Analysis and Forecasting
This course is designed to provide the student with solid practical skills in implementing basic statistical and machine learning techniques for the purpose of predictive analytics. Throughout the course, many real world case studies are used to motivate and explain the strengths and appropriateness of each method of interest. In those case studies, students will learn how to apply data cleaning, visualization, and other exploratory data analysis tools to a variety of real world complex data. Students will gain experience with reproducibility and documentation of computational projects and with developing basic data products for predictive analytics. The following techniques will be implemented and then tested with cross-validation: regularization in linear models, regression and smoothing splines, k-nearest neighbor, and tree-based methods, including random forest. (Prerequisites: STAT-611 and STAT-741 or equivalent course.) Lecture, Credits 3 (Spring)

STAT-778  Advanced Programming in R
Advanced Programming in R

STAT-789  Special Topics
This course provides for the presentation of subject matter of specialized value in the field of applied statistics not offered as a regular part of the program. (This course is restricted to students with graduate standing in the APPSTAT-MS or APPSTAT-BS/MS or STATQL-Act or SMPPI-Act program.) Lecture/Lab, Credits 1 - 3 (Fall, Spring)

STAT-790  Thesis
For students working toward the MS degree who are writing a research thesis. (Enrollment in this course requires permission from the department offering the course.) Thesis, Credits 1 - 6 (Fall, Summer)

STAT-791  Continuation of Thesis
(Enrollment in this course requires permission from the department offering the course.) Continuation, Credits 0 (Fall, Summer)

STAT-792  Capstone
Capstone
STAT-795  Graduate Seminar
This course provides for one or more semesters of study and research activity. This course is required for all first-year full-time funded students in the MS program. (Enrollment in this course requires permission from the department offering the course.) Lecture, Credits 0 (Fall, Spring, Summer)

STAT-799  Independent Study
Credit will be assigned at the discretion of the department. A written proposal of the work involved will be required of the candidate, and may be modified at the discretion of the faculty involved before approval is given to proceed. (Enrollment in this course requires permission from the department offering the course.) Independent Study, Credits 1 - 3 (Fall, Spring, Summer)
### Architecture

**ARCH-611 Architectural Representation I**
This course introduces the range of architectural representation skills necessary to effectively document geometric forms and simple architectural form and space. Skill development will be both manual and digital and include free-hand sketching, 3-D modeling, 2-D drafting, paraline drawings, perspectives, and presentation techniques. (ARCH-MARCH) Studio, Credits 3 (Fall)

**ARCH-612 Architectural Representation II**
This course deepens the study of architectural representation skills necessary to effectively document more complex architectural form and space. Skill development will be both manual and digital and include free-hand sketching, 3-D modeling, 2-D drafting, paraline drawings, perspectives, and presentation techniques. (Prerequisites: ARCH-611 or equivalent course.) Studio 2, Credits 3 (Spring)

**ARCH-621 Architectural History I**
Students will study the history of architecture for both western and non-western traditions from the beginning of human shelter and the patterns of early communities through the end of the Medieval period in Europe. The sub-theme of sustainability will be explored by illustrating how ancient building designs modified the effects of climate without the use of large amounts of wealth or energy. (ARCH-MARCH) Lecture 3, Credits 3 (Fall)

**ARCH-622 Architectural History II**
Students will study the history of architecture for both western and non-western traditions from the Renaissance to the present day. The sub-theme of sustainability will be explored by illustrating how ancient building designs modified the effects of climate without the use of large amounts of wealth and energy. (ARCH-MARCH) Lecture 3, Credits 3 (Spring)

**ARCH-631 Architectural Design I**
Students will develop acuity of formal/spatial principles, and will develop presentation and self-critique skills. Projects articulate coherent sets of architectural intentions and aim to develop the spatial, structural, and organizational tools of the beginning designer. Students will also have the opportunity for basic synthesis and application of visual and tectonic communication skills necessary to convey architectural design concepts. (Co-requisites: ARCH-611 or equivalent course.) Studio 3, Credits 6 (Fall)

**ARCH-632 Architectural Design II**
With a focus on residential and small scale design, students will communicate and analyze building based architectural design concepts. Students will continue to develop acuity of formal/spatial principles, and will further develop presentation and self-critique skills. Projects articulate coherent sets of architectural intentions and aim to further develop the spatial, structural, and organizational tools of the beginning designer. (Co-requisites: ARCH-612 and ARCH-741 or equivalent courses.) Studio 3, Credits 6 (Spring)

**ARCH-641 Fundamentals of Building Systems**
In this course, students will receive an overview of the various systems that comprise a building project but also focus on residential construction. Systems studied will include architectural material and methods, land use, site, climate, human factors, building structure systems and active and passive support systems. The constraints that control these systems will also be studied such as building and zoning codes, construction costs, and sustainability factors. (Co-requisites: ARCH-632 or equivalent course.) Lecture 3, Credits 3 (Spring)

**ARCH-699 Coop Architecture**
This course provides a ten-week (350-400 hours) work experience in the field. Note: Second year program status (ARCH-MARCH) Co-op, Credits 0 (Summer)

**ARCH-731 Architectural Studio I: Site**
Building on the 1st year studios that explored basic communications between form and space this introduction to the 2nd year will investigate in greater depth the complexity and integrated nature of the architectural object and design process. Students will explore the artistic, conceptual, creative, and experiential side of architecture as a way of developing a rigorous process of architectural form-making. By developing methods, parameters, and alternatives of form-making, issues such as expression, perception, and representation will be explored. Although site design will be the focus of the course, full building designs will be examined in response to site parameters. Students will be expected to work in teams to explore communally a broad spectrum of design strategies at every opportunity. (Prerequisites: ARCH-632 or equivalent course. Co-requisites: ARCH-741 or equivalent course.) Studio 3, Credits 6 (Fall)

**ARCH-732 Architectural Studio II: Tectonic**
This foundation studio considers architecture both as a representation and as a built form. It will expand student horizons beyond the confines of the studio by bridging the gap between theory (representation) and practice (action). Architects are responsible for shaping the built environment and this studio will provide students with a first-hand experience of the professional responsibility to the public. Through the process of design students will be making strong connections between drawing/representation and the finished building produced. (Prerequisites: ARCH-731 or equivalent course. Co-requisites: ARCH-743 or equivalent course.) Studio 3, Credits 6 (Spring)

**ARCH-733 Architectural Studio III: Adaptive**
This course examines the adaptive reuse of existing spaces, with implicit exposure to the basics of historic preservation. Students will examine and document an existing "real" space within the region, and propose coherent and rational architectural interventions for that space. (Prerequisites: ARCH-732 or equivalent course. Co-requisites: ARCH-744 or equivalent course.) Studio 3, Credits 6 (Fall)

**ARCH-734 Architectural Studio IV: Urban**
This studio builds upon and expands the students design skills in architecture through the lens of urban design and landscape architecture, and introduces the new dynamic of community leadership and urban planning. The approach to urban design engages the city as an integrated design problem that is best solved through a participatory and engaged design process. Drawing on expertise from a variety of disciplines and skill sets, students will study the process of working directly in the community to create visions for future change. The studio is intended to inform an understanding of building design in relation to the urban context. The course is devoted to expanding and developing design skills at the block and neighborhood scale. (Prerequisites: ARCH-733 or equivalent course. Co-requisites: ARCH-745 or equivalent course.) Studio 3, Credits 6 (Spring)

**ARCH-735 Architecture Studio IV: Integrative**
This studio provides the opportunity for students to execute a comprehensive and integrative project from schematic design through design development. (Prerequisites: ARCH-733 or equivalent course. Co-requisites: ARCH-744 or equivalent course.) Lecture 3, Studio 9, Credits 6 (Spring)

**ARCH-741 Integrated Bldg Systems I**
This course presents the various systems that comprise a project’s site work; architectural materials/methods, civil engineering, and landscaping architecture as well as site constraints. (Prerequisites: ARCH-641 or equivalent course. Co-requisite: ARCH-731 or equivalent course.) Lecture 3, Credits 3 (Fall)

**ARCH-742 Integrated Building Systems II**
The major tectonic components of a building will be studied in this course focusing on the building envelope and typical structural configurations. Structural inquiry will fully cover the field of statics. (Prerequisites: ARCH-741 or equivalent course. Co-requisites: ARCH-732 or equivalent course.) Lecture 3, Credits 3 (Spring)

**ARCH-743 Integrated Building Systems III**
Typical interior building components will be studied in this course from subdivision of space down to selection of material finishes as they relate to building code regulations. Structural inquiry will continue with full coverage of strength of materials. (Prerequisites: ARCH-742 or equivalent course. Co-requisites: ARCH-733 or equivalent course.) Lecture 3, Credits 3 (Fall)

**ARCH-744 Integrated Building Systems IV**
Various building core and sub-systems will be studied in this final course of the sequence including acoustics and illumination. A deeper inquiry into mechanical, electrical, and plumbing systems will also occur. (Prerequisites: ARCH-743 or equivalent course. Co-requisites: ARCH-733 or equivalent course.) Lecture 3, Credits 3 (Spring)
ARCH-751 Architectural Theory
A survey of architectural theory and criticism with emphasis on the period from the mid-twentieth century to the present. This course offers students the opportunity to investigate, learn, and apply critical thinking in the context of architecture and communicating these findings to others. (Prerequisites: ARCH-621 and ARCH-622 or equivalent courses.) Lecture 3, Credits 3 (Fall)

ARCH-752 Urban and Regional Planning
This course immerses students in the field of urban and regional planning as individuals as well as part of a team. By working with area planning organizations and/or agencies, teams of students will provide community service in the design process for neighborhoods, small towns/villages, or regions. (Prerequisites: ARCH-621, ARCH-622 and ARCH-632 or equivalent courses.) Lecture 3, Credits 3 (Spring)

ARCH-753 Research Seminar/Thesis Prep
This seminar experience exposes architecture students to a range of contemporary architectural, social, and urban issues along with the historical content that underlies the development of these issues. Selected readings from current periodicals, critical writing, group dialogue, presentations, and guest lectures will be integrated into the course as appropriate. In preparation for the culminating studio experience students will also engage in seminar format research, through analysis of precedent, site investigation, critical readings and exploration of technique. Through this, each student will be required to develop a proposal as the basis for their thesis proposal. (ARCH-MARCH) Lecture 3, Credits 3 (Fall)

ARCH-761 Understanding Sustainability
This course will introduce graduate students to the fundamental concepts related to interaction of industrial and environmental/ecological systems, sustainability challenges facing the current generation, and systems-based approaches required to create sustainable solutions for society. Students will understand critical thinking and the scientific method as it applies in a systems-based, transdisciplinary approach to sustainability, and be prepared to identify problems in sustainability and formulate appropriate solutions based in scientific research, architecture, or applied science. (This class is restricted to graduate students in the Golisano Institute for Sustainability (ARCH-MARCH, SUSTSY-MS, SUST-PHD).) Lecture 3, Credits 3 (Fall)

ARCH-762 Industrial Ecology Fundamentals
Industrial ecology is the study of the interaction between industrial and ecological systems. Students in this course learn to assess the impact and interrelations of built environments on the natural environment by utilizing life cycle assessment tools and principles of sustainability. (Prerequisite: ARCH-761 or equivalent course.) Lecture 3, Credits 3 (Spring)

ARCH-763 Sustainable Building Metrics
This course addresses the measurement science, performance metrics, assessment tools, and fundamental data critical for the development and implementation of building systems associated with the life cycle operation of buildings while simultaneously maintaining a healthy and productive indoor environment. Certification processes and design guides, such as LEED, Lab21®, and the Whole Building Design Guide, among others will also be reviewed. (This class is restricted to graduate students in the Golisano Institute for Sustainability (ARCH-MARCH, SUSTSY-MS, SUST-PHD).) Lecture 3, Credits 3 (Fall)

ARCH-771 Professional Practice
Students will study the role and responsibilities of architects engaged in professional practice. One focus will be on the various players and the process of project delivery and management. Affiliated issues of ethics, professional development, and legal responsibilities will also be covered. (ARCH-MARCH) Lecture 3, Credits 3 (Spring)

ARCH-789 Architecture Special Topics
A critical examination of issues in some area of sustainability not covered in other Golisano Institute for Sustainability courses. Topic depends on specific offering. Lecture 3, Credits 1 - 6 (Fall, Spring)

ARCH-790 Thesis
This course is the culminating studio experience for the M.Arch. program. Students will propose, design, and defend an architectural design or research problem, while working closely with a selected faculty committee. (Prerequisites: ARCH-753 or equivalent course.) Thesis 6, Credits 6 (Fall)

ARCH-791 Continuation of Thesis
(Prerequisites: ARCH-790 or equivalent course.) Continuation, Credits 0 (Fall, Spring, Summer)

ARCH-799 Independent Study
Independent Study 4, Credits 1 - 4 (Fall, Spring, Summer)
Life cycle assessment (LCA) is a tool used in the field of industrial ecology to evaluate the environmental impacts of products or processes over their entire life cycle — from raw material extraction, manufacturing, use, and end-of-life management. This course will build on the fundamentals of LCA by allowing students to conduct project-based studies on the environmental impacts of products or processes. Students will apply process, economic input-output, and hybrid methodologies to evaluate technological systems for opportunities of environmental improvement. Lecture 3, Credits 3 (Spring)

Applied Life Cycle Assessment

This class will explore the economic and environmental incentives for recycling and resource recovery. The focus will be on end-of-life fate of materials (including plastics, metals, glass, and e-waste) while setting these within the context of overall ecosystem flows (carbon, sulfur, and nitrogen cycles, waste water, etc.). Technologies for the upgrading of secondary material streams will be studied including: physical and physico-chemical (beneficiation, electrostatic and magnetic separation), hydrometallurgical (selective precipitation, leaching, ion exchange), biotechnological (biosorption, sulfate reduction), and pyrometallurgical (filtration and fluxing). Production issues (product quality, remelt thermodynamics, exergy accounting, etc.) within the secondary industry will be explored with an emphasis on removing barriers to increased usage of scrap. Efforts for enhanced collection efforts and motivation of consumer and firm participation will also be covered (municipal collection fees, corporate take-back initiatives, legislation such as the WEEE directive, state deposits, etc.) Lecture 3, Credits 3 (Fall)

Materials Cycling

This class will explore the economic and environmental incentives for recycling and resource recovery. The focus will be on end-of-life fate of materials (including plastics, metals, glass, and e-waste) while setting these within the context of overall ecosystem flows (carbon, sulfur, and nitrogen cycles, waste water, etc.). Technologies for the upgrading of secondary material streams will be studied including: physical and physico-chemical (beneficiation, electrostatic and magnetic separation), hydrometallurgical (selective precipitation, leaching, ion exchange), biotechnological (biosorption, sulfate reduction), and pyrometallurgical (filtration and fluxing). Production issues (product quality, remelt thermodynamics, exergy accounting, etc.) within the secondary industry will be explored with an emphasis on removing barriers to increased usage of scrap. Efforts for enhanced collection efforts and motivation of consumer and firm participation will also be covered (municipal collection fees, corporate take-back initiatives, legislation such as the WEEE directive, state deposits, etc.) Lecture 3, Credits 3 (Fall)