ENGINEERING MECHANICS AND ASTRONAUTICS (E M A)

E M A 1 — COOPERATIVE EDUCATION PROGRAM
1 credit.

Work experience which combines classroom theory with practical knowledge of operations to provide students with a background upon which to base a professional career in industry.

Requisites: So st
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2017

E M A 110 — INTRODUCTION TO PRIVATE PILOT
4 credits.

The first course of a two-course series to earn a private pilot’s license. This first course will teach students all of the ground-school subjects necessary to become a private pilot. Lecture topics include aircraft structure, mechanical systems, flight instruments and avionics, aerodynamics, aircraft performance, aviation meteorology, airport operations, navigation, aero-medical factors, rules and regulations. In-class discussion will center around PC-based simulation scenarios that feature classroom demonstrations of the theory taught online. Students will be charged flight fees for this course. Flight fees may vary, dependent on skill of student and instructor fees. See the class notes for information about fees.

Requisites: None
Repeatable for Credit: No
Last Taught: Fall 2016

E M A 201 — STATICS
3 credits.

Principles of mechanics, force systems, equilibrium, structures, distributed forces, moments of inertia of areas, and friction. Open to Freshmen.

Requisites: MATH 222 or concurrent registration.

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Summer 2017

E M A 202 — DYNAMICS
3 credits.

Kinematics, force-mass-acceleration relations, work and energy, impulse and momentum, moments of inertia and mass.

Requisites: EMA 201 or 214; and MATH 222; or consent of instructor

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Summer 2017

E M A 291 — PROJECTS IN ENGINEERING MECHANICS & ASTRONAUTICS
1-3 credits.

Individual engineering projects under staff supervision. Prereqs: None
Repeatable for Credit: No
Last Taught: Spring 2016

E M A 303 — MECHANICS OF MATERIALS
3 credits.

Stress and strain, torsion, bending of beams, shearing stresses in beams, compound stresses, principal stresses, deflections of beams, statically indeterminate members, columns. For civil engineers.

Requisites: EMA 201 MATH 222

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Summer 2017

E M A/M E 307 — MECHANICS OF MATERIALS LAB
1 credit.

Data processing, tension/compression tests, creep stress concentrations, fatigue, fracture, composite materials, combined stress, beam flexure, dynamic loads, buckling.

Requisites: ME 306 or concurrent registration
Repeatable for Credit: No
Last Taught: Summer 2017

E M A/CIV ENGR 395 — MATERIALS FOR CONSTRUCTED FACILITIES
3 credits.

Properties and tests of materials used in the initial construction or repair of facilities (including buildings, transportation systems, utility systems, and reinforced earth). Introduction to laboratory and field measurement techniques to assess material performance capabilities. Technical report preparation.

Requisites: EMA 303 307

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

E M A 405 — PRACTICUM IN FINITE ELEMENTS
3 credits.

Use of finite elements (FE) for solving practical problems in mechanics. Elementary theory of FE is discussed. A commercial computer program is used for applications. Major emphasis is on behavior of FE, modeling, and evaluation of results for correctness.

Requisites: EMA 214, 303, 304, or 306; EMA 202 or 221; knowledge of elementary matrix algebra or consent of instructor

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2017
E M A/CBE/CHEM/M E 425 — UNDERGRADUATE RHEOLOGY SEMINAR
1 credit.
Rheology seminar course encouraged for all interested in professions related to polymers, suspensions or rheology; will not count toward credit requirement of the major.
Requisites: Cons inst or Jr st
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2011

E M A 469 — DESIGN PROBLEMS IN ENGINEERING
3 credits.
The design philosophy is presented. Students will be required to apply their knowledge of elementary mechanics, engineering and basic science to arrive at acceptable solutions to a variety of design problems.
Requisites: EMA 221, 307; ECE 376; ME 363, 361; MSE 350; or cons inst
Repeatable for Credit: No
Last Taught: Fall 2016

E M A/E P 471 — INTERMEDIATE PROBLEM SOLVING FOR ENGINEERS
3 credits.
Use of computational tools for the solution of problems encountered in engineering physics applications. Topics covered include orbital mechanics, structural vibrations, beam and plate deformations, heat transfer, neutron diffusion, and criticality. Emphasis will be on modeling, choice of appropriate algorithms, and model validation.
Requisites: MATH 319 NEEP 271 or COMP SCI 310
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2017

E M A/E P 476 — INTRODUCTION TO SCIENTIFIC COMPUTING FOR ENGINEERING PHYSICS
3 credits.
Basic tools of professional scientific computation for UNIX environments are taught. Programming skills in a compiled language are developed through engineering examples. Applications reinforce engineering problem-solving skills first examined in introductory courses, while motivating progressively more advanced computational methods.
Requisites: NEEP 271 or COMP SCI 310; COMP SCI 412 or equivalent; MATH 319; or consent of instructor
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2016

E M A 489 — HONORS IN RESEARCH
1-3 credits.
Undergraduate research and senior honors thesis in engineering mechanics and astronautics.
Requisites: Honors candidacy in engineering mechanics
Course Designation: Honors - Honors Only Courses (H)
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2009

E M A 506 — ADVANCED MECHANICS OF MATERIALS I
3 credits.
Analysis and design of load-carrying members, shear center, unsymmetrical bending, curved beams, beams on elastic foundations, energy methods, theories of failure, thick-walled cylinders, stress concentrations, design to prevent failure by excessive elastic deformation, plastic deformation and fracture.
Requisites: EMA 214, 304, or 306/307
Repeatable for Credit: No
Last Taught: Fall 2016

E M A/E M E 508 — COMPOSITE MATERIALS
3 credits.
Physical properties and mechanical behavior of polymer, metal, ceramic, cementitious, cellulosic and biological composite systems; micro- and macro-mechanics; lamination and strength analyses; static and transient loading; fabrication; recycling; design; analytical-experimental correlation; applications.
Requisites: ME 342 or ME 444 or ME/EMA 570 or EMA 506 or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2015

E M A 519 — FRACTURE MECHANICS
3 credits.
Introduction to the mechanics of fracture of linear and nonlinear materials. Crack stress and deformation fields; stress intensity factors; crack tip plastic zone; fracture toughness testing; energy release rate; J-integral. Criteria for crack growth initiation/stability; application to design.
Requisites: EMA 214, 304, or 306/307
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017
**E M A 521 — AERODYNAMICS**

3 credits.

Potential flow theory; stream functions; vortex filaments and sheets. Two- and three-dimensional wing theory. Doublet and panels methods. Propeller theory.

**Requisites:** EMA 202; CEE 310 or ME 363; MATH 234; or consent of instructor

**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

**Level - Advanced**

**L&S Credit:** Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Fall 2016

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**E M A 522 — AERODYNAMICS LAB**

3 credits.

Teams of two or three students perform case study of a wing using computer simulations and lab experiments. Experimental and computational results are compared against theoretical predictions developed in prerequisite class. Results are presented in three oral and three written reports.

**Requisites:** EMA 521

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

**Last Taught:** Spring 2017

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**E M A 523 — FLIGHT DYNAMICS AND CONTROL**

3 credits.


**Requisites:** EMA 521 542

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

**Last Taught:** Spring 2017

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**E M A/M S & E 541 — HETEROGENEOUS AND MULTIPHASE MATERIALS**

3 credits.


**Requisites:** EMA 303 or ME 306 or MSE 441 or equivalent

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

**Last Taught:** Fall 2016

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**E M A 542 — ADVANCED DYNAMICS**

3 credits.

Kinematics and kinetics of plane and three-dimensional motion, Coriolis acceleration, general methods of linear and angular momentum, central force motion, gyro dynamics, generalized coordinates. Lagrange’s equations.

**Requisites:** EMA 202 or 221; EMA 307; Math 223; or consent of instructor

**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

**Level - Advanced**

**L&S Credit:** Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Fall 2016

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**E M A 545 — MECHANICAL VIBRATIONS**

3 credits.

General theory of free, forced, and transient vibrations; vibration transmission, isolation, and measurement; normal modes and generalized coordinates; method of matrix equation formulation and solution. The application of theory and methods to the analysis, measurement and design of dynamic systems.

**Requisites:** EMA 202 or 221; EMA 307; Math 223; or consent of instructor

**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

**Level - Advanced**

**L&S Credit:** Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Fall 2016

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**E M A/E P 547 — ENGINEERING ANALYSIS I**

3 credits.

Methods of higher mathematics; stress on problem solving rather than rigorous proofs; linear algebra, calculus of variations, Green’s function.

**Requisites:** A year of advanced calculus such as MATH 321 322

**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

**Level - Intermediate**

**L&S Credit:** Counts as Liberal Arts and Science credit in L&S

**Grad 50% - Counts toward 50% graduate coursework requirement**

**Repeatable for Credit:** No

**Last Taught:** Fall 2016
E M A/E P 548 — ENGINEERING ANALYSIS II
3 credits.

Function of complex variable, series solution of different equations, partial differential equations.

**Requisites:** A year of math beyond calculus

**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

**Last Taught:** Spring 2017

E M A/ASTRON 550 — ASTRODYNAMICS
3 credits.

Coordinate system transformations, central force motion, two body problem, three and n-body problem, theory of orbital perturbations, artificial satellites, elementary transfer orbits, and elementary rocket dynamics.

**Requisites:** EMA 202 or 221; or PHYSICS 311 or con reg; or cons inst

**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Spring 2017

E M A 569 — SENIOR DESIGN PROJECT
3 credits.

Students will select specific engineering design projects. These projects will be student team efforts supervised by individual faculty members.

**Requisites:** EMA 469, any two of EMA 542, 545, 506; or consent of instructor

**Repeatable for Credit:** No

**Last Taught:** Spring 2017

E M A/M E 570 — EXPERIMENTAL MECHANICS
3 credits.

Experimental methods for design and analysis of mechanical components, structures and materials. Electrically and optically recorded stress, strain and deformation data; computer acquisition/reduction/presentat techniques; applications to static and transient events, sensors, transducer design, NDT, fracture and residual stresses.

**Requisites:** ME 306 or EMA 214 or 303 or 304 or cons inst

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

**Last Taught:** Fall 2016

E M A 599 — INDEPENDENT STUDY
1-3 credits.

**Requisites:** Cons inst

**Course Designation:** Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** Yes, unlimited number of completions

**Last Taught:** Summer 2017

E M A 601 — SPECIAL TOPICS IN ENGINEERING MECHANICS
1-3 credits.

Selected topics in such areas as structural mechanics, dynamics, experimental mechanics, vibrations, engineering materials, soil mechanics, engineering analysis, rheology, etc.

**Requisites:** Cons inst

**Repeatable for Credit:** Yes, unlimited number of completions

**Last Taught:** Summer 2017

E M A 605 — INTRODUCTION TO FINITE ELEMENTS
3 credits.

A first course in finite elements, with theory and applications in stress analysis and in areas related to structural mechanics. Practice in the use and/or development of computer programs.

**Requisites:** EMA 303, 304 or ME 306; MATH 340; or cons inst

**Repeatable for Credit:** No

**Last Taught:** Fall 2016

E M A 610 — STRUCTURAL FINITE ELEMENT MODEL VALIDATION
3 credits.

An introduction to test-based validation of finite element models for the design and analysis of dynamic structures.

**Requisites:** EMA 405, EMA 545 or ME 440

**Repeatable for Credit:** No

**Last Taught:** Spring 2017

E M A 611 — ADVANCED MECHANICAL TESTING OF MATERIALS
3 credits.

Theory and use of servo-controlled, electro-hydraulic equipment for research of mechanical properties of engineering materials. Measurement of stress, strain, hysteresis energy, and material properties during deformation and at fracture. Analysis of four significant components of total strain.

**Requisites:** EMA 307 either EMA 506 or con reg in EMA 506

**Repeatable for Credit:** No

**Last Taught:** Spring 2017

E M A/E P 615 — MICRO- AND NANOSCALE MECHANICS
3 credits.

An introduction to micro- and nanoscale science and engineering with a focus on the role of mechanics. A variety of micro- and nanoscale phenomena and applications covered, drawing connections to both established and new mechanics approaches.

**Requisites:** EMA 303 or ME 306 or consent of instructor

**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Spring 2012
E M A 622 — MECHANICS OF CONTINUA
3 credits.

Tensor analysis; analysis of stress, strain and rate of strain; application of Newtonian mechanics to deformable media; mechanical constitutive equations; field equations of fluid mechanics and elasticity.

Requisites: MATH 340 MATH 321 or consent of instructor

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2017

E M A 630 — VISCOELASTIC SOLIDS
3 credits.


Requisites: EMA 506 or equiv; or EMA 303 cons inst

Repeatable for Credit: No

Last Taught: Fall 2015

E M A 642 — SATELLITE DYNAMICS
3 credits.

Review of Euler's equations, torque-free motion, stability of rotation, energy dissipation effects, gyroscopic instruments, gyrodynamics of the Earth, gravity gradient stabilized satellites, spin stabilized satellites, dual spin satellites, tethered satellites, mass movement techniques, space vehicle motion and rocket dynamics.

Requisites: EMA 542

Repeatable for Credit: No

Last Taught: Spring 2017

E M A 690 — MASTER'S RESEARCH
1-9 credits.

Requisites: Grad st

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Summer 2017

E M A 700 — THEORY OF ELASTICITY
3 credits.

Equations of elasticity in curvilinear and rectangular coordinates; two dimensional problems; problems of prismatic bars; variational methods and energy principles; complex variable and numerical methods; thermal stress problems.

Requisites: EMA 506 MATH 321 or cons inst

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2016

E M A 702 — GRADUATE COOPERATIVE EDUCATION PROGRAM
1-2 credits.

Work experience that combines classroom theory with practical knowledge of operations to provide students with a background on which to develop and enhance a professional career. The work experience is tailored for MS students from within the U.S. as well as eligible international students.

Requisites: Graduate or professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Summer 2017

E M A 703 — LINEAR VISCOELASTICITY AND PLASTICITY
3 credits.


Requisites: EMA 622 or cons inst

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2015

E M A 705 — ADVANCED TOPICS IN FINITE ELEMENTS
3 credits.


Requisites: EMA 605

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2016

E M A/M E 706 — PLATES, SHELLS AND PRESSURE VESSELS
3 credits.

Stress and deflection analysis of structural plates and membranes under mechanical and thermal loads; variational and numerical methods; instability and vibrations; membrane shell theory; cylindrical shells; pressure vessel and piping design applications; ASME Pressure Vessel Code.

Requisites: ME 444 or EMA 506 or cons inst

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2017
E M A/M E 708 — ADVANCED COMPOSITE MATERIALS
3 credits.

Contemporary topics such as new materials; smart materials/structures/systems; fatigue; fracture; experimental techniques; nondestructive evaluation; transient, micro, three-dimensional, nonlinear, inelastic and environmental effects; manufacturing methods: repair and applications.

Requisites: ME/EMA 508 or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2016

E M A 719 — ADVANCED FRACTURE MECHANICS
3 credits.

Rigorous, systematic development of principal concepts and theories of modern fracture mechanics. Topics include stress and deformation fields for stationary and growing cracks in linear elastic, nonlinear elastic, elastic-plastic and viscoelastic materials; J-integral theory and applications; criteria for crack growth, stability and fracture.

Requisites: EMA 519 622, or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 1998

E M A/M E 722 — INTRODUCTION TO POLYMER RHEOLOGY
3 credits.

Formulation of constitutive equations using embedded base vectors. Viscosity, normal stress differences, stress relaxation, elastic recoil. Polymer rheology; homogeneous strain history.

Requisites: MATH 320 or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2012

E M A 742 — THEORY AND APPLICATIONS IN ADVANCED DYNAMICS
3 credits.


Requisites: EMA 542 or PHYSICS 311 or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2015

E M A 745 — ADVANCED METHODS IN STRUCTURAL DYNAMICS
3 credits.

Emphasis is placed on techniques used to analyze aerospace structures. Variational principles, Hamilton’s extended principle, Lagrange’s equations, mathematical models for continuous systems, natural modes of vibrations, dynamic response using mode superposition, mode acceleration, residual flexibility, vibration analysis using finite element methods, advanced substructure representations, component mode synthesis, systems with rigid body modes for aeronautical and astronautical systems.

Requisites: EMA 545, EMA 405 or equiv or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2016

E M A 747 — NONLINEAR AND RANDOM MECHANICAL VIBRATIONS
3 credits.

Exact solutions and sectorial linearization; free and forced vibration of mechanical systems with nonlinear restoring force; self-excited mechanical vibrations and relaxation vibrations; subharmonic responses; nonlinear vibration of mechanical systems with more than one degree of freedom; nonlinear vibration of bounded continuous media; random excitation and random response, random vibrations of mechanical systems and structures; random vibrations of nonlinear mechanical systems; failure of materials under random vibrations.

Requisites: EMA 745
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

E M A/COMP SCI/E C/E E P/M E 759 — HIGH PERFORMANCE COMPUTING FOR APPLICATIONS IN ENGINEERING
3 credits.

An overview of hardware and software solutions that enable the use of advanced computing in tackling computationally intensive Engineering problems. Hands-on learning promoted through programming assignments that leverage emerging hardware architectures and use parallel computing programming languages.

Requisites: COMP SCI 302 or COMP SCI 368
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2015

E M A 790 — MASTER’S RESEARCH AND THESIS
1-9 credits.

For Master’s candidates only

Requisites: Grad st.
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2017
E M A/M E 825 — MOLECULAR NETWORK THEORIES FOR POLYMERIC MATERIALS
3 credits.


Requisites: Cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

E M A 890 — PRE-DISSERTATOR RESEARCH
1-9 credits.

For pre-dissertator stdts only
Requisites: Grad st.
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement.
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2017

E M A/CBE/CHM/M E 925 — RHEOLOGY RESEARCH SEMINAR
1 credit.

Exploration of the most recent research literature on viscoelasticity, constitutive equations, non-Newtonian flow systems, fluid metering devices, kinetic theory of macromolecules, and rheooptical phenomena. Periodic reports on recent advances made by research workers in the various rheology groups on the Madison campus.

Requisites: Graduate or professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2011

E M A 990 — RESEARCH AND THESIS
1-12 credits.

Requisites: Dissertator status
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2017