Fall 2020 Course Descriptions as of 04/05/2020 08:13 PM

Information in Browse Course Catalog is subject to change. Information is term specific. Please refer to the appropriate term when searching for course content. Key to Course Descriptions may be found at: **http://rcs.registrar.arizona.edu/course_descriptions_key**.

Planetary Sciences (PTYS)

PTYS 170A1: Planet Earth: Evolution of the Habitable World (3 units)
Description: This course develops a planetary perspective on the evolutionary processes that shaped Earth throughout history. We will examine why Earth is habitable, that is, why any kind of life can live on it, we will discuss the unique influences that biological processes and atmosphere/ocean systems have on each other, and we will review current notions of climate change, including evidence for the influence of human activities on it. This interdisciplinary treatment of Earth and its sister planets will encourage students to think about how science and engineering must be applied to today's challenges if humankind is to have a promising future on (and off) this planet.
Grading basis: Regular Grades
Career: Undergraduate

Course Components:	Discussion	May Be Offered
	Lecture	Required

Equivalent to: GEOS 170A1
Also offered as: ASTR 170A1
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Enrollment not allowed if you have previously taken NATS 101 "A Geological Perspective" (Topic 1) or "Planet Earth: Evolution of the Habitable World " (Topic 9) or GEOS 170A1 or GEOG 150S1 or PTYS/ASTR 170S1.
General Education: NATS 101

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

PTYS 170B2: The Universe and Humanity: Origin and Destiny (3 units)
Description: This course explores the deep relationships that connect the largest structures in the universe to the world of atoms and subatomic particles. Topics covered begin with the scientific method and tools of science, proceed to fundamental physical concepts and processes that govern the natural world, and move on to a study of features of the natural world based upon fundamental laws of nature. This knowledge is used to create a broad perspective for understanding the origin and evolution of our Milky Way Galaxy, our Solar System, and their common cosmic heritage.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion — May Be Offered
Lecture — Required
Equivalent to: ASTR 170B1
Also offered as: ASTR 170B2
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Enrollment not allowed if you have previously taken ASTR 170B1 or NATS 102 "The Physical Universe" (Topic 4) or NATS 102 "The Universe and Humanity: Origin and Destiny" (Topic 6).
General Education: NATS 102

PTYS 170S1: Evolution of a Sustainable World (3 units)
Description: This new hybrid course combines "Environment and Society" (GEOG 150C1) with "Evolution of a Habitable World" (PTYS/ASTR 170A1). We survey the natural sciences behind conditions that can support life on planets like Earth as well as the social science perspectives regarding how humans choose to interact with and influence the environment. This course also explores pathways to a sustainable future on Earth, including lessons for life and our possible relocation to other planets. Students can enroll through either PTYS/ASTR 170A1 (for Tier-1 NATS GenEd credit) or GEOG 150C1 (for Tier-1 INDV GenEd credit).
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture — Required
Also offered as: ASTR 170S1
Co-convened with: GEOG 150S1
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: Students who complete this course not eligible for GEOG150C1 nor PTYS/ASTR170A1.
Field trip: None
Enrollment requirement: Must not have taken GEOG 150C1 or PTYS/ASTR 170A1.
Honors Course: Honors Contract
Honors Course: Honors Contract

PTYS 195A: Planetary Sciences (1 unit)
Description: Freshmen and other first year students are encouraged to enroll in one-unit First Year Colloquia that allow for in-depth exploration of a science topic. Colloquia feature lively discussion and class participation. Topics vary by semester (e.g., "The Changing Sun and its Influence on Earth: Does the Sun's natural variability affect climate on Earth?" and "Why do we have a space program?"). For further information, contact the Department of Planetary Sciences.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Colloquium Required
Course typically offered:
Main Campus: Fall, Spring

Freshman Colloquia: Freshman Colloquia

PTYS 199: Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

PTYS 199H: Honors Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course

PTYS 206: Exploring Our Solar System (3 units)
Description: Our Solar System is filled with an incredible diversity of objects. These include the sun and planets, of course, but also many hundreds of moons -- some with exotic oceans, erupting volcanoes, or dynamic atmospheres. Billions of asteroids and comets inhabit the space between and beyond the planets. Each body is unique, and has followed its own evolutionary history. This class will explore our current understanding of the Solar System and emphasize similarities that unite the different bodies as well as the differences between them. We will develop an understanding of physical processes that occur on these bodies, including tectonics, impact cratering, volcanism, and processes operating in their interiors, oceans, and atmospheres. We will also discuss planets around nearby stars and the potential for life beyond Earth. Throughout the class, we will highlight the leading role that the University of Arizona has played in exploring our Solar System.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ASTR 206
Also offered as: ASTR 206
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: Two courses from Tier One, Natural Sciences (NATS 101, 102, 104).
General Education: Tier 2 Natural Sciences

PTYS 212: The Science and Politics of Global Warming (3 units)
Description: The fundamental principles of the greenhouse effect will be addressed in a quantitative manner. This will require knowledge of the nature of light, temperature, their measurement, black body radiation, atmospheric structure, composition and opacity, as well as basic concepts of radiative transfer. These topics will be covered in a set of formal lectures, home works, class papers/projects and laboratory exercises during roughly the first two thirds of the course. The last third of the course will be devoted to the economic /political aspects of global warning.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

General Education: Tier 2 Natural Sciences

PTYS 214: Astrobiology: A Planetary Perspective (3 units)
Description: We will explore questions about the origin, evolution, and future of life on Earth and the possibility of life arising independently elsewhere in the Universe. We will examine what it means for a planet to be habitable, both in terms of basic necessities for living organisms to function and environmental limits to their ability to survive. Finally, we will review different approaches for searching for life within the Solar System and beyond using direct and remote sensing techniques.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ASTR 202, ASTR 214, GEOS 214
Also offered as: ASTR 214, GEOS 214
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: two courses from Tier One, Natural Sciences (NATS 101, 102, 104).
Enrollment requirement: Enrollment not allowed if you have previously taken ASTR 202.
General Education: Tier 2 Natural Sciences
Honors Course: Honors Contract
Honors Course: Honors Contract

PTYS 299: Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

PTYS 299H: Honors Independent Study (1 - 5 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

PTYS 342: Life on Mars in Fact and Fiction (3 units)
Description: This course will combine an exploration of the scientific searches for life on Mars, from the 19th Century to present, with an exploration of science fiction based on Mars. As well as providing a background for students to understand past, present and future searches for life on Mars, this course will also provide a framework for students to understand how science fiction about Mars fits in with both the science of the day and with previous science fiction. PTYS 342 may not be used to satisfy requirements for the PTYS undergraduate minor.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $87
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

PTYS 392: Directed Research (1 - 6 units)
Description: Individual or small group research under the guidance of faculty.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated for a maximum of 12 units.
Course typically offered:
Main Campus: Fall, Spring, Summer

Honors Course: Honors Contract
Honors Course: Honors Contract

PTYS 395B: Topics in Planetary Science (1 unit)
Description: This one-unit colloquium course features discussion on topics in Planetary Science. Topic and instructor vary by term.
Grading basis: Student Option ABCDE/PF
Career: Undergraduate
Course Components: Colloquium Required
Course typically offered:
Main Campus: Fall, Spring

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

PTYS 399: Independent Study (1 - 5 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 5 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

PTYS 399H: Honors Independent Study (1 - 5 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 5 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course

PTYS 403: Physics of the Solar System (3 units)
Description: Survey of planetary physics, planetary motions, planetary interiors, geophysics, planetary atmospheres, asteroids, comets, origin of the solar system.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ASTR 403, GEOS 403
Also offered as: ASTR 403, GEOS 403, PHYS 403
Course typically offered:
Main Campus: Spring (odd years only)

Recommendations and additional information: PHYS 142 or PHYS 251.

PTYS 407: Chemistry of the Solar System (3 units)
Description: Abundance, origin, distribution, and chemical behavior of the chemical elements in the Solar System. Emphasis on applications of chemical equilibrium, photochemistry, and mineral phase equilibrium theory.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: CHEM 407
Course typically offered:
Main Campus: Fall (odd years only)

Recommendations and additional information: CHEM 104B, MATH 129 or their equivalents.

PTYS 411: Geology and Geophysics of the Solar System (3 units)
Description: Geologic processes and landforms on satellites and the terrestrialplanets, their modification under various planetary environments, andmethods of analysis. Required course for the undergraduate minor inPlanetary Sciences.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Also offered as: GEOS 411, HWRS 411
Course typically offered:
Main Campus: Spring (even years only)

PTYS 413: Planetary Materials (3 units)
Description: This course discusses chemical thermodynamics and applies it to the origins and history of planetary materials. The types of planetary materials will be discussed together with an overview of the chemical setting of their origins. We will discuss thermodynamic formalism, the various chemical pathways through which planetary materials are believed to have formed, the characterization and numerical methods we use to quantify such origins, and we will consider several case studies.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: PTYS 513
Course typically offered:
Main Campus: Spring

Field trip: N/A

PTYS 416: Asteroids, Comets and Kuiper Belt Objects (3 units)
Description: This is an introduction to the "minor planets," the asteroids, comets and Kuiper Belt objects. The focus will be on origin and evolution (including current evolution), as well as techniques of study. It will include an evening at the telescope of an asteroid search program.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: PTYS 516
Course typically offered:
Main Campus: Fall

PTYS 442: Mars (3 units)
Description: In-depth class about the planet Mars, including origin and evolution, geophysics, geology, atmospheric science, climate change, the search for life, and the history and future of Mars exploration. There will be guest lectures from professors and research scientists with expertise about aspects of Mars. The course may include visits to Mars exploration centers at the University of Arizona and Arizona State University. There will be lots of discussion of recent results and scientific controversies about Mars. All students are expected to have a knowledge of basic calculus.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ASTR 442, GEOS 442
Also offered as: ASTR 442, GEOS 442
Co-convened with: PTYS 542
Course typically offered:
Main Campus: Spring (odd years only)

Recommendations and additional information: PTYS 411 is strongly recommended but not required.

PTYS 450: Origin of the Solar System and Other Planetary Systems (3 units)
Description: This course will review the physical processes related to the formation and evolution of the protosolar nebula and of protoplanetary disks. In doing that, we will discuss the main stages of planet formation and how different disk conditions impact planetary architectures and planet properties. We will confront the theories of disk evolution and planet formation with observations of circumstellar disks, exoplanets, and the planets and minor bodies in our Solar System.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Also offered as: ASTR 450
Co-convened with: PTYS 550
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Undergraduate students who have successfully completed two upper division science classes are eligible to take this class.

PTYS 492: Directed Research (1 - 6 units)
Description: Individual or small group research under the guidance of faculty.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated for a maximum of 12 units.
Course typically offered:
Main Campus: Fall, Spring, Summer

Honors Course: Honors Contract
Honors Course: Honors Contract

PTYS 495B: Special Topics in Planetary Science (1 - 3 units)
Description: Course will emphasize emerging and current topical research in Planetary Science; course will be offered as needed or required. Sample course topics might include an active spacecraft mission, an emerging research area, or new discoveries. Graduate-level requirements may include an additional project for graduate credit and extra questions on exams, depending on the course/topic taught. Sections of this course may be offered for 1-3 units, depending on topic.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Colloquium Required
Repeatable: Course can be repeated a maximum of 3 times.
Co-convened with: PTYS 595B
Course typically offered:
Main Campus: Fall, Spring

Field trip: Field trips are a possibility for some special topics; examples would include visits to a telescope or local geological site.

PTYS 498: Senior Capstone (1 - 3 units)
Description: A culminating experience for majors involving a substantive project that demonstrates a synthesis of learning accumulated in the major, including broadly comprehensive knowledge of the discipline and its methodologies. Senior standing required.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Course typically offered:
Main Campus: Fall, Spring, Summer

PTYS 498H: Honors Thesis (3 units)
Description: An honors thesis is required of all students graduating with honors. Students ordinarily sign up for this course as a two-semester sequence. The first semester the student performs research under the supervision of a faculty member; the second semester the student writes an honors thesis. Maximum 3 enrollments.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 3 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course

PTYS 499: Independent Study (1 - 5 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

PTYS 499H: Honors Independent Study (1 - 5 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course

PTYS 502: Analytical and Numerical Modeling in Geosciences (3 units)
Description: Analytical and numerical solutions to partial differential equations and other models widely used in disparate fields of geosciences
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ECOL 502, MCB 502
Also offered as: GEOS 502
Recommendations and additional information: MATH 129. Open to advanced undergraduates with strong mathematical backgrounds and consent of instructor and Graduate College.
Home department: Geosciences

PTYS 503: Physics of the Solar System (3 units)
Description: Survey of planetary physics, planetary motions, planetary interiors, geophysics, planetary atmospheres, asteroids, comets, origin of the solar system. Graduate-level requirements include an in-depth research paper on a selected topic and an oral class presentation.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ASTR 503, GEOS 503
Also offered as: ASTR 503, GEOS 503, PHYS 503
Co-convened with: PTYS 403
Course typically offered:
Main Campus: Spring (odd years only)

PTYS 505A: Principles of Planetary Physics (3 units)
Description: Introductory physics of planetary and interplanetary fluids, plasmas, and solid bodies. Thermodynamics, kinetic theory, fluid dynamics, transport theory, rotational and tidal response theory and orbital mechanics, applied to solar system objects. Students will be expected to be familiar with vector calculus and ordinary and partial differential equations. In addition, students will be expected to know, or learn, a programming language such as C, Fortran, IDL or MATLAB.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall (even years only)

Recommendations and additional information: Classical and quantum mechanics at the level of PHYS 151 and PHYS 242.

PTYS 505B: Principles of Planetary Physics (3 units)
Description: Introductory physics of planetary and interplanetary fluids, plasmas, and solid bodies. Thermodynamics, kinetic theory, fluid dynamics, transport theory, rotational and tidal response theory and orbital mechanics, applied to solar system objects.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall (odd years only)

Recommendations and additional information: classical and quantum mechanics at the level of PHYS 151 and PHYS 242.

PTYS 510A: Cosmochemistry (3 units)
Description: This course discusses the chemical processes important for the formation of our solar system and that subsequently acted on the objects within the solar system. It also discusses nuclear processes responsible for synthesis of the elements and alteration of isotopic abundances.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring (even years only)

PTYS 510B: Chemistry of the Solar System (3 units)
Description: Overview of gas and ice chemistry in planetary environments including molecular structure, spectroscopy, kinetics. Course describes how these physical processes are manifest in the diverse solar system environments. Instructional level is aimed at beginning graduate students with an adequate background comparable to that obtained from advance undergraduate courses in physics and chemistry. Successful students will be able to understand current research in planetary chemistry and will be well prepared for more detailed studies.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring (odd years only)

Recommendations and additional information: Knowledge of vector calculus and elementary differential equations is assumed.

PTYS 512: Planetary Global Tectonics (3 units)
Description: Application of the physics of solid-state deformation to global tectonics of the terrestrial planets and icy moons of the solar system. Modes of topographic support, isostacy and implications for gravity/topography ratios on one-plate planets. Theory of floating elastic plates as an approximation to the lithosphere. Use of seismic data to determine the interior structure and composition and modes of heat conduction in planets.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall (even years only)

PTYS 513: Planetary Materials (3 units)
Description: This course discusses chemical thermodynamics and applies it to the origins and history of planetary materials. The types of planetary materials will be discussed together with an overview of the chemical setting of their origins. We will discuss thermodynamic formalism, the various chemical pathways through which planetary materials are believed to have formed, the characterization and numerical methods we use to quantify such origins, and we will consider several case studies.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: MSE 513
Co-convened with:
Course typically offered:
Main Campus: Spring

Field trip: None

PTYS 516: Asteroids, Comets and Kuiper Belt Objects (3 units)
Description: This is an introduction to the "minor planets," the asteroids, comets and Kuiper Belt objects. The focus will be on origin and evolution (including current evolution), as well as techniques of study. It will include an evening at the telescope of an asteroid search program. Graduate-level requirements include homework sets and a written paper incorporating original work or calculations. Must research a primary topic and lead a class discuss focused on the topic.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: PTYS 416
Course typically offered:
Main Campus: Fall

PTYS 517: Atmospheres and Remote Sensing (3 units)
Description: Structure, composition, and evolution of atmospheres; atomic and molecular spectroscopy; radiative transfer and spectral line formatting.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring (odd years only)

PTYS 518: Instrumentation and Statistic (3 units)
Description: Radiant energy; signals and noise; detectors and techniques for imaging, photometry, polarimetry and spectroscopy. Examples from stellar and planetary astronomy in the x-ray, optical, infrared and radio. Graduate-level requirements include an in-depth research paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ATMO 518, PTYS 518
Also offered as: ASTR 518
Course typically offered:
Main Campus: Fall (even years only)

Home department: Astronomy

PTYS 519: Physics of the Earth (3 units)
Description: Fundamentals of the physics of the solid earth, including thermodynamics, rheology, geomagnetism, gravity, and plate tectonics. Graduate-level requirements include a term paper in publication format on some aspect of a major course topic.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: PTYS 519
Also offered as: GEOS 519
Co-convened with: PTYS 419
Home department: Geosciences

PTYS 520: Meteorites (3 units)
Description: Classification; chemical, mineralogical and isotopic composition; cosmic abundances; ages; interaction with solar and cosmic radiation; relation to comets and asteroids.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: GEOS 520
Also offered as: GEOS 520

PTYS 521: Observational Planetary Astronomy & Remote Sensing (3 units)
Description: The course will survey current techniques and instrumentation used in observational astronomy. The goal is to provide students with background that will allow them to consider the observational (empirical) basis of planetary astronomy, and begin to design observations to test their understanding of planetary atmospheres, surfaces, and orbital and bulk characteristics. The first 2 months will consist of lectures in order to give students a physical understanding of modern telescopes, optical configurations (e.g. adaptive optics), detectors, statistics, spectrometers and spacecraft instrumentation. The class will discuss UV, optical, infrared, sub-millimeter and radar techniques, as well as the basics of radiative transfer. The second half of the course will proceed more like a workshop. Part of the focus will be on the completion of the main assignment in the course, an observing proposal to a major observatory. This half of the class will also delve more deeply into the most recent innovative techniques used in planetary astronomy.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

PTYS 522: Planetary Climate (3 units)
Description: Physical and chemical processes governing the climate of planets. Climate feedbacks and stability; greenhouse effect, ice-albedo feedback, cloud feedbacks. Effect of atmospheric circulation on climate. Milankovitch cycles and ice ages. Long-term atmospheric evolution; runaway greenhouse, Snowball Earth, atmospheric loss/collapse, faint young Sun problem. Interaction of climate with geology/biology. Observational signatures. Habitable zones. Application to Earth, Mars, Venus, Titan, and habitability of extrasolar planets.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required

PTYS 526: Nanoscale Analysis of Materials Using Transmission Electron Microscopy (3 units)
Description: This course discusses the theory and practice of transmission electron microscopy as applied to crystalline solids. Topics to be covered include electron scattering and diffraction, image formation, energy-dispersive X-ray spectroscopy and electron energy-loss spectroscopy. Weekly lectures will be accompanied by several laboratory practical sessions. Emphasis will be placed on quantitative analysis of material structure and composition as well as the identification of unknown materials.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $100
Course Components: Lecture Required
Also offered as: MSE 526
Course typically offered:
Main Campus: Fall (even years only)

PTYS 530: The Chemical Evolution of Earth (3 units)
Description: [Taught alternate years beginning Fall 2004]. Chemical differentiation and evolution of Earth's mantle and crust according to major-element, trace-element and isotopic characteristics of neodymium, hafnium, strontium, lead and other isotopes. Graduate-level requirements will include an additional paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: PTYS 530
Also offered as: GEOS 530
Co-convened with: PTYS 430
Field trip: Field trips.
Home department: Geosciences

PTYS 537: The Physics of the Sun (3 units)
Description: The purpose of this course is to present an introduction to the physics of the Sun. The course begins with a discussion of the standard solar model, the solar-neutrino problem, and observational techniques. Long-term variability in the total irradiance, sunspot number, and diameter, and its effect on Earth's climate will be addressed in some detail. Other topics include the physics of the solar interior, solar oscillations, and solar composition. This course will also introduce the equations of magnetohydrodynamics and apply them to important solar-physics problems, such as: the solar magnetic dynamo, stability of prominences, physics of sunspots and flares, and heating of the solar atmosphere. The emphasis throughout will be on basic physical processes and the various approximations used in their application to concrete problems.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ASTR 537, ATMO 537, PHYS 537
Also offered as: ASTR 537, ATMO 537, PHYS 537

PTYS 541A: Dynamic Meteorology I (3 units)
Description: Thermodynamics and its application to planetary atmospheres, hydrostatics, fundamental concepts and laws of dynamic meteorology. Graduate-level requirements include a more quantitative and thorough understanding of the subject matter.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: PTYS 541A
Also offered as: ATMO 541A
Co-convened with:
Course typically offered:
Main Campus: Fall

Home department: Hydrology and Atmospheric Sciences

PTYS 541B: Dynamic Meteorology II (3 units)
Description: Thermodynamics and its application to planetary atmospheres, hydrostatics, fundamental concepts and laws of dynamic meteorology. Graduate-level requirements include a more quantitative and thorough understanding of the subject matter.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: PTYS 541B
Also offered as: ATMO 541B
Co-convened with:
Course typically offered:
Main Campus: Spring

Home department: Hydrology and Atmospheric Sciences

PTYS 542: Mars (3 units)
Description: In-depth class about the planet Mars, including origin and evolution, geophysics, geology, atmospheric science, climate change, the search for life, and the history and future of Mars exploration. There will be guest lectures from professors and research scientists with expertise about aspects of Mars. The course may include visits to Mars exploration centers at the University of Arizona and Arizona State University. There will be lots of discussion of recent results and scientific controversies about Mars. All students are expected to have a knowledge of basic calculus. Graduate-level requirements include the completion of a research project that will be presented in class as well as a report. The research project could be analysis of Mars datasets, a laboratory experiment, or new theoretical modeling.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ASTR 542, GEOS 542
Also offered as: ASTR 542, GEOS 542
Co-convened with: PTYS 442
Course typically offered:
Main Campus: Spring (odd years only)

Recommendations and additional information: PTYS 511, Geology of the Solar System is strongly recommended but not required.

PTYS 544: Physics of High Atmospheres (3 units)
Description: Physical properties of upper atmospheres, including gaseous composition, temperature and density, ozonosphere, and ionospheres, with emphasis on chemical transformations and eddy transport.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ATMO 544
Also offered as: ATMO 544

PTYS 545: Stars and Planets (4 units)
Description: This course will explore the physical principles that govern the structure and evolution of stars and planets. Topics covered will include hydrostatic equilibrium, energy generation and transport, dimensional analysis, equations of state, and fluid dynamics. Applying physical models and computational methods, fundamental properties of stars and planets will be derived, and compared with observational constraints.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ASTR 545
Course typically offered:
Main Campus: Fall (odd years only)

Home department: Astronomy

PTYS 549: Radar Remote Sensing of Planetary Surfaces (4 units)
Description: This graduate course will focus on the use of radar remote sensing for studies of planetary surfaces, including rocky and icy objects. It will cover the basics of how radar works including SAR and sounding (ground penetrating) radar, the use of different frequencies, an introduction to electromagnetic wave propagation including polarimetry, radar data processing, and the use of radar field equipment. The course will include a discussion of some of the past, current and future radars included on spacecraft and their design and science results. The course will be focused on geosciences; in particular, applications relevant to planetary processes such as regolith development, volcanism, cratering, fluvial deposits etc. This class includes 3 hours/week lecture plus a lab and fieldwork component.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Lecture Required
Also offered as: GEOS 549
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Field work (trips of 1 or 2 days) will involve using ground penetrating radar and other instruments to investigate subsurface stratigraphy. Lab component may involve demonstrations, work on in-lab radar equipment, testing, field trip preparation.
Field trip: Yes

PTYS 550: Origin of the Solar System and Other Planetary Systems (3 units)
Description: This course will review the physical processes related to the formation and evolution of the protosolar nebula and of protoplanetary disks. In doing that, we will discuss the main stages of planet formation and how different disk conditions impact planetary architectures and planet properties. We will confront the theories of disk evolution and planet formation with observations of circumstellar disks, exoplanets, and the planets and minor bodies in our Solar System. Graduate-level requirements include advanced quantitative problems in homeworks and tests.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ASTR 550
Co-convened with: PTYS 450
Course typically offered:
Main Campus: Fall

Recommendations and additional information: All students enrolled in the astronomy, physics, planetary science, and optical science Ph.D. programs may enroll.

PTYS 551: Remote Sensing of Planetary Surfaces (4 units)
Description: This graduate course will focus on the use of remote sensing in the study of rocky and icy planetary surfaces. It is not a science course, but rather intended to provide technical knowledge of how instruments work and practical techniques to deal with their datasets. In this course, we will cover how different types of remote-sensing instruments work in theory and practice along with case studies (student-led) of specific planetary science instruments. We will discuss what datasets are generated by these instruments, their limitations and where they can be located. Lab sessions will provide experience in how these data are processed, visualized and intercompared. The class consists of two lectures and a 2.5-hour lab session each week.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Lecture Required
Also offered as: GEOS 551
Course typically offered:
Main Campus: Fall (even years only)

Recommendations and additional information: Introductory experience with coding and GIS is helpful but not required. Students may use programming language or GIS software they find efficient. Examples in this class will typically utilize Python and QGIS respectively.

PTYS 553: Solar System Dynamics (3 units)
Description: Dynamical processes affecting the orbital evolution of planets, asteroids, and satellites, and the rotational evolution of solid bodies. Emphasizes modern nonlinear dynamics and chaos.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ASTR 553
Course typically offered:
Main Campus: Spring (even years only)

Recommendations and additional information: MATH 254, PHYS 422 or consult department before enrolling.

PTYS 554: Evolution of Planetary Surfaces (3 units)
Description: The geologic processes and evolution of terrestrial planet and satellite surfaces including the Galilean and Saturnian and Uranian satellites. Course includes one or two field trips to Meteor Crater or other locales.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $195
Course Components: Lecture Required
Equivalent to: GEOS 554
Also offered as: GEOS 554
Course typically offered:
Main Campus: Fall (odd years only)

PTYS 558: Plasma Physics with Astrophysical and Solar System Applications (3 units)
Description: The goal of this course is to present an introduction to fundamental plasma physics and magnetohydrodymics, beginning with kinetic theory. The various important limits including the vlasov equation and magnetohydrodynamics will be derived. Applications will be mostly from astrophysics and the solar system. These will include the main dynamical processes in the solar atmosphere, interplanetary medium, magnetospheres, interstellar medium, blast waves, accretion disks, etc. The emphasis throughout will be on basic physical processes and the various approximations used in their application to concrete problems.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ASTR 558, PHYS 558
Also offered as: ASTR 558, PHYS 558
Course typically offered:
Main Campus: Spring

PTYS 567: Inverse Problems in Geophysics (3 units)
Description: [Taught alternate years beginning Fall 2005]. Linear and nonlinear inverse theory, including least squares, generalized and maximum likelihood methods.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ATMO 567, PTYS 567
Also offered as: GEOS 567
Recommendations and additional information: Experience with linear algebra recommended.
Home department: Geosciences
Interdisciplinary Interest Area: ATMO - Atmospheric Sciences

PTYS 568: Exoplanets: Discovery and Characterization (3 units)
Description: One of the greatest discoveries in recent decades is that a majority of stars have planets orbiting them. The diversity of these so-called Exoplanets is incredible, greatly exceeding that in our own Solar System by spanning a huge range in mass, age, temperature, composition and orbital properties. These exotic worlds are broadening the scope of planetary science to include new physical regimes. Examples include atmospheres heated to star-like temperatures, near-supersonic atmospheric winds and peculiar chemical compositions. This course will introduce planetary science concepts relevant to exoplanet atmospheres, interiors, and evolution, as well as the techniques used for discovery and characterization. The course content will include guest lectures by experts in the field, student-led discussions of recent results and discoveries, and projects involving real exoplanet observational data.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

PTYS 575: Planetary Astrobiology (3 units)
Description: The course will explore the processes related to planet formation and the emergence of life. We will study the formation of our Solar System and exoplanetary systems, the conditions that gave rise to life on the Earth, and the potential habitability of other planets/moons in our system or extrasolar systems. Graduate-level requirements include advanced homework assignments and written examination.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ASTR 575
Course typically offered:
Main Campus: Spring (odd years only)

Home department: Astronomy
Interdisciplinary Interest Area: GEOS - Geosciences

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

PTYS 578: Writing Across the Space Sciences (3 units)
Description: The purpose of this class is to strengthen the writing skills of the student along the entire range of writing, from technical scientific writing in the space sciences to popular articles about science. It has the secondary purpose of preparing the student for the wide variety of occasions when communication skills, written and verbal, will be required in the professional practice of the space sciences.
Grading basis: Regular Grades
Career: Graduate
Course Components: Discussion — May Be Offered
Lecture — Required
Also offered as: ASTR 578
Recommendations and additional information: Graduate standing.
Home department: Astronomy

PTYS 579: Boundary Layer Meteorology & Surface Processes (3 units)
Description: Designed for students in the atmospheric sciences, hydrology and related fields. It provides a framework for understanding the basic physical processes that govern mass and heat transfer in the atmospheric boundary layer and the vegetated land surface. In addition to the theoretical part of the course, there is a strong focus on modeling and students will be required to program numerical codes to represent these physical processes.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture — Required
Repeatable: Course can be repeated a maximum of 2 times.
Also offered as: ATMO 579, ENVS 579, HWRS 579, WSM 579
Course typically offered:
Main Campus: Spring (even years only)

Recommendations and additional information: MATH 223, PHYS 141, PHYS 253.
Home department: Hydrology and Atmospheric Sciences

PTYS 582: High-Energy Astrophysics (2 units)
Description: A study of pulsars, black holes, accretion disks, X-ray binaries, gamma-ray sources, radio galaxies, active galactic nuclei, and the acceleration of charged particles near these objects, together with the radiation mechanisms they employ to produce the high-energy emission we detect at Earth.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture — Required
Repeatable: Course can be repeated a maximum of 2 times.
Also offered as: ASTR 582
Course typically offered:
Main Campus: Spring (even years only)

Home department: Astronomy
Interdisciplinary Interest Area: PHYS - Physics

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

PTYS 584: The Coevolution of Earth and the Biosphere (3 units)
Description: This course examines the interplay of changes in earth environments and biological evolution from the earliest life to the present. The focus is geochemical and topics include the early earth and life, evolutionary jumps, mass extinctions, and the rise of hominids. Graduate level requirements include multiple in-class presentations/reviews on journal articles.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $31
Course Components: Lecture Required
Also offered as: ASTR 584, GEOS 584
Recommendations and additional information: Calculus II (MATH 129) or consent of the instructor.
Field trip: 2-3 field trips to geologic localities near Tucson, Arizona.
Home department: Geosciences

PTYS 588A: Astrochemistry (3 units)
Description: This astrochemistry course is the study of gas phase and solid state chemical processes that occur in the universe, including those leading to pre-biotic compounds. Topics include chemical processes in dying stars, circumstellar gas, planetary nebulae, diffuse clouds, star-forming regions and proto-planetary discs, as well as planets, satellites, comets and asteroids. Observational methods and theoretical concepts will be discussed. Graduate-level requirements include a project and an oral exam.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ASTR 588A
Course typically offered:
Main Campus: Fall (odd years only)

Recommendations and additional information: Consent of instructor.
Home department: Astronomy
Interdisciplinary Interest Area: CHEM - Chemistry

PTYS 589: Topics of Theoretical Astrophysics (3 units)
Description: Current topics in theoretical astrophysics in depth, with emphasis on the methodology and techniques of the theorist and the cross-disciplinary nature of astrophysics theory. Example subjects are nuclear astrophysics, hydrodynamics, transient phenomena, planetary interiors and atmospheres, neutron stars, jets and the evolution of star clusters.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 2 times.
Equivalent to: ASTR 589, PTYS 589
Also offered as: PHYS 589
Course typically offered:
Main Campus: Spring (odd years only)

Home department: Physics
Interdisciplinary Interest Area: ASTR - Astronomy

PTYS 594A: Planetary Geology Field Studies (1 unit)
Description: The acquisition of first-hand experience with geologic processes and features, focusing on how those features/processes relate to the surfaces of other planets and how accurately those features/processes can be deduced from remote sensing data. This is a three- to five-day field trip to an area of geologic interest where each student gives a short presentation to the group. This trip typically involves camping and occasional moderate hiking; students need to supply their own camping materials. Trip is led by a Planetary Sciences faculty member once per semester.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Flat Fee: $150
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 10 times.
Course typically offered:
Main Campus: Fall, Spring

Field trip: This is a three- or four-day field trip to area of geologic interest.

PTYS 595B: Special Topics in Planetary Science (1 - 4 units)
Description: Course will emphasize emerging and current topical research in Planetary Science; course will be offered as needed or required. Sample course topics might include an active spacecraft mission, an emerging research area, or new discoveries. Graduate-level requirements will include an additional project for graduate credit and extra questions on exams, depending on the course/topic taught. Sections of this course may be offered for 1-3 units, depending on topic.
Grading basis: Regular Grades
Career: Graduate
Course Components: Colloquium Required
Repeatable: Course can be repeated a maximum of 4 times.
Co-convened with: PTYS 495B
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: Field trips are a possibility for some special topics; examples would include visits to a telescope or local geological site.

PTYS 596A: Planetary Surfaces Processes Seminar (1 unit)
Description: This seminar course will focus on discussion of planetary surfaces and their evolution, including geology of rocky planets and moons, icy surfaces and moons, regolith development, surface-atmosphere interactions, sub-surface structure and interiors, and climate change. The course will involve the exchange of scholarly information in a small group setting, including presentations and discussions of student research, reviews of recent science results and discussion of proposal ideas. Students will be expected to lead 1-2 presentations and participate in group discussions. This course is intended for graduate students; senior undergraduates may be able to enroll with permission of the instructor.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Seminar Required
Repeatable: Course can be repeated a maximum of 10 times.
Course typically offered:
Main Campus: Fall, Spring

Field trip: N/A

PTYS 596B: Methods in Computational Astrophysics (3 units)
Description: The course is a "hands-on" introduction to computer use for research by scientists in astrophysics and related areas. The course begins with a survey of and introduction to tools available on Linux systems, web-based tools, and open-source software widely used in astrophysics. Standard methods for integration, iteration, differential and difference equations, and Monte Carlo simulations, are discussed, in one to four dimensions. Historically important methods of radiative transfer, reaction networks, and hydrodynamics are presented, and contrasted with presently-used methods. Parallel programming is introduced, and discussed in terms of new and future computer systems. Special topics are added to reflect new developments. The course is task-oriented, with individual and team work projects, and class participation determining grades. Most of the work is done on the student's own personal computer (Linux or Mac operating systems are preferred).
Grading basis: Student Option ABCDE/PF
Career: Graduate
Course Components: Seminar Required
Equivalent to: PHYS 596B, PTYS 596B
Also offered as: ASTR 596B
Course typically offered:
Main Campus: Spring (odd years only)

Home department: Astronomy
Interdisciplinary Interest Area: PHYS - Physics

PTYS 597: Introduction to Planetary Science for Teachers (3 units)
Description: The general objective of this course is to provide an introduction to the dynamic range of processes, features, and histories of the solar system and its bodies. We'll take a tour of solar system formation, compare surface processes (e.g. impact cratering, volcanism) on different planets, discuss near earth asteroids and their interaction with Earth, and a host of other exciting topics. Our knowledge of what is happening in space around us has grown dramatically in the last several decades as we send more spacecrafts out to distant planets and places. We will discuss what kinds of data those spacecrafts collect, how we use it to explore the solar system, and what kinds of discoveries we've made about our planet-neighbors. This is an introductory course designed to provide a basic framework of planetary science content for high school and middle school science teachers. It will not focus on the application of content in other classrooms, however some activities will be included to help students adapt content for their own use.All discussion, activities, and lectures will be done entirely online through the University's D2L system. Opportunities for synchronous discussion can be arranged if there is sufficient interest. The course will be primarily narrative driven, however students should have a basic knowledge of algebra. In general, we will have three major areas of focus: basic content, scientific data, and scientific literacy. A list of topics is provided at the end of the syllabus.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required

PTYS 599: Independent Study (1 - 5 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

PTYS 641: Advanced Atmospheric and Oceanic Fluid Dynamics (3 units)
Description: Fundamentals and theory of the large-scale circulation of the atmosphere and oceans. Hierarchy of equation sets used in geophysical fluid dynamics. Concepts of balance, vorticity, potential vorticity. Barotropic and baroclinic instability. Wave mean-flow interactions. Atmosphere/ocean turbulence. Dynamics of Hadley cells and jet streams; role of Rossby waves, gravity waves, and baroclinic eddies in helping to maintaining the mean flow. Applicaiton of this theory to understand the fundamental mechanisms controlling the tropospheric and stratospheric circulation of the Earth and other planets. Basics of oceanic circulation, including wind-driven gyres, buoyancy-driven (overturning) circulation, and thermocline dynamics.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ATMO 641
Course typically offered:
Main Campus: Spring (odd years only)

Recommendations and additional information: Students must have familiarity with calculus, differential equations, and basic atmospheric dynamics at the level of ATMO 541A or equivalent.
Home department: Hydrology and Atmospheric Sciences

PTYS 656A: Atmospheric Radiation and Remote Sensing (3 units)
Description: Theory of atmospheric radiative transfer processes; specific methods for solving the relevant equations; applications to problems in radiative transfer; theoretical basis for remote sensing from the ground and from space; solutions to the "inverse" problem.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 656A, PTYS 656A
Also offered as: ATMO 656A, OPTI 656A
Course typically offered:
Main Campus: Fall

Recommendations and additional information: MATH 254.
Home department: Hydrology and Atmospheric Sciences

PTYS 656B: Atmospheric Radiation and Remote Sensing (3 units)
Description: Theory of atmospheric radiative transfer processes; specific methods for solving the relevant equations; applications to problems in radiative transfer; theoretical basis for remote sensing from the ground and from space; solutions to the "inverse" problem.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 656B
Also offered as: ATMO 656B, OPTI 656B
Course typically offered:
Main Campus: Spring

Recommendations and additional information: MATH 254.
Home department: Hydrology and Atmospheric Sciences

PTYS 699: Independent Study (1 - 5 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.

PTYS 900: Research (1 - 8 units)
Description: Individual research, not related to thesis or dissertation preparation, by graduate students.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

PTYS 909: Master's Report (3 - 6 units)
Description: Individual study or special project or formal report thereof submitted in lieu of thesis for certain master's degrees.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

PTYS 910: Thesis (1 - 4 units)
Description: Research for the master's thesis (whether library research, laboratory or field observation or research, artistic creation, or thesis writing). Maximum total credit permitted varies with the major department.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

PTYS 920: Dissertation (1 - 9 units)
Description: Research for the doctoral dissertation (whether library research, laboratory or field observation or research, artistic creation, or dissertation writing).
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer