Department of Philosophy Courses

About Course Numbers:
Each Carnegie Mellon course number begins with a two-digit prefix that designates the department offering the course (i.e., 76-xxx courses are offered by the Department of English). Although each department maintains its own course numbering practices, typically, the first digit after the prefix indicates the class level: xx-1xx courses are freshmen-level, xx-2xx courses are sophomore level, etc. Depending on the department, xx-6xx courses may be either undergraduate senior-level or graduate-level, and xx-7xx courses and higher are graduate-level. Consult the Schedule of Classes (https://len Apps.as.cmu.edu/open/SGC/SGCService/) each semester for course offerings and for any necessary pre-requisites or co-requisites.

80-100 Introduction to Philosophy
All Semesters: 9 units
Even philosophers have a hard time explaining what exactly philosophy is. Instead of attempting a definition, one might instead list some of the questions philosophers try to answer. Like most other academic fields, philosophy has its own sub-disciplines, and each of these has its own questions it tries to answer. In this course, we will be looking at questions from several of these areas of philosophy, including: What is the mind? Do we have free will? What does the answer to that question mean for practices of reward and punishment? Is morality relative? What, if anything, is its connection to religion? How can I know the right thing to do? How can I know anything? This class isn’t a historical introduction to philosophy, and we will be jumping around through history and subjects as we please, concerned only with interesting questions and good answers. As a whole, the course will strongly emphasize some of the basic skills of doing just about any kind of philosophy: how to recognize and understand arguments, how to evaluate them, and how to construct your own. As it turns out, these are skills you need to successfully navigate your way through just about any field of study and any career. This course will include a fair amount of writing, but you’ll be getting lots of help from me, from your TA, and even from your peers.

80-101 Dangerous Ideas in Science and Society
Fall and Spring: 9 units
Should we use genetic engineering technology to create super-intelligent babies? When, if ever, can a doctor kill a patient or help her die? If we can in the future, should we end human aging, allowing people to live for thousands of years? Is it possible to survive your bodily death (e.g., by "uploading"?), or are you a human animal that will die with its body? Has neuroscience shown that free will is an illusion? Could a digital computer ever be programmed to have a mind? What is romantic love and could it make sense to think you’re in a relationship with an AI? What is the probability that you are a Sim living in an advanced civilization’s computer simulation? Do people actually believe fake news, or are people smarter than that? When, if ever, is it rational to believe conspiracy theories? These are some of the toughest, most pressing questions of current philosophical inquiry. Philosophers address them by producing intricate and often beautiful arguments. In this course, you will assess those arguments and produce your own. You will learn to think like a philosopher to strip an argument presented in prose to its bare essentials and plainly expose its structure. This course will improve the clarity and rigor of your own thinking and writing. It will put you in a position to make progress on hard questions like those mentioned above. And it will improve your ability to crisply convey your ideas - an ability that will serve you well not just in class, but also in daily life. That just one class can make you meaningfully smarter may seem wild. But it’s true. For evidence, see Prof. Cullen’s article in Nature Science of Learning, which demonstrates large gains on LSAT logical reasoning forms in a multi-year study of Princeton University undergraduates who learned the same technique taught in this class: https://www.nature.com/articles/s41539-018-0036-5

80-130 Introduction to Ethics
Fall: 9 units
Philosophical ethics, or moral philosophy, covers a lot of ground. It asks and tries to answer questions like: What’s good in life? What matters? What should I (and others) do? How should I (and others) act? What kinds of things out there must be treated ethically? Do we have moral duties to (at least some) non-human animals? Is morality subjective? Are there actually any objective moral truths? Morally speaking, what (if anything) is the difference between killing someone, and simply letting them die? In trying to answer these questions (and others), we’ll engage in some wonderfully weird thought experiments, class discussions, smaller group discussions, debates, etc. We’ll study and critique several moral theories which try to explain and help guide our moral judgments, and we’ll try to apply these theories to real-life moral controversies. Past classes covered topics including drug prohibition, abortion, euthanasia, and physician-assisted suicide. This is an introductory philosophy class, so you’ll be learning how to read, critique, do, and write philosophy generally, not just ethics. Considerable time and effort, both in lectures and in recitations, will be spent helping you learn to recognize and evaluate philosophical arguments, as well as empowering you to create, improve, and defend your own arguments in class assignments.

80-135 Introduction to Political Philosophy
Spring: 9 units
At the heart of political philosophy lie fundamental questions such as: What constitutes a just society? How, and under what circumstances do individuals incur political obligations to a particular state? This course provides a systematic investigation of the way such questions are answered by dominant schools of liberal political theory, such as the social contract tradition, utilitarianism and libertarianism. Later we will introduce critiques from socialist, and feminist theorists. Readings are drawn from classic works by authors such as Plato, Hobbes and Locke, and from the works of more contemporary theorists like Rawls, and Nozick.

80-136 Social Structure, Public Policy & Ethics
Intermittent: 9 units
At the heart of political philosophy lie fundamental questions such as: What constitutes a just society? How, and under what circumstances do individuals incur political obligations to a particular state? This course provides a systematic investigation of the way such questions are answered by dominant schools of liberal political theory, such as the social contract tradition, utilitarianism and libertarianism. Later we will introduce critiques from socialist, and feminist theorists. Readings are drawn from classic works by authors such as Plato, Hobbes and Locke, and from the works of more contemporary theorists like Rawls, and Nozick.

80-150 Nature of Reason
Spring: 9 units
This course provides an accessible introduction to the historical development of philosophical ideas about the nature of reasoning and rationality (with a focus on mathematics and the sciences), from ancient to modern times. The first part of the course traces the search for deductive methods for obtaining certain knowledge, starting with Aristotle and Euclid all the way to the work of Boole and Frege in the 19th century. The second part of the course considers the history of skepticism about empirical knowledge, covering Plato, Descartes, Pascal, and Hume, along with replies to skepticism in the works of Bayes and Kant. The third part of the course discusses theories of the nature of the mind and mental processes, culminating in the computational conception of the mind that underlies contemporary cognitive science.
80-180 Nature of Language
Fall and Spring: 9 units
Language is used to talk about the world or to describe it, but how do we go about describing language itself? Linguistics is the name given to the science of language, whose task it is to give such a description. The discipline of linguistics has developed novel tools for describing and analyzing language over the last two hundred years and in this course we will use these tools and practice applying them. The courses will include phonetics (the study of speech sounds), phonology (the study of sound systems), morphology (the study of parts of words), and syntax (the study of combinations of words), Furthermore, we will highlight various aspects in which language and linguistics interacts with societal issues. The methods of linguistics are useful in the study of particular languages and in the study of language generally, so this course is useful for students of foreign languages as well as those interested in going on to study language acquisition, psycholinguistics, sociolinguistics, philosophy of language, and computer modeling of language.

80-184 Disagreeable Language: talk in the age of polarization
Intermittent: 9 units
What do you do when confronted with opinions that (to you) are obviously wrong - supported by facts that are not even based in (your) reality? This is a situation we more and more find ourselves facing, or would if we ever ventured out of our own ideological bubble (which is constantly replenished by Big Tech and only with information pre-matched to our biases). It is held in place by human language itself - our supposed primary means of communication. While it is true that pictures can lie -- one hundred years ago Arthur Conan Doyle got taken in by the Cottingley pixie photographs, and now there's CGI and Deepfake -- language has always been the premier instrument for the conveyance of untruths. And when the facts themselves are up for grabs, the traditional approach -- going outside of language for confirmation and fact-checking -- doesn't work either. Can anything be done about this precarious situation? Disagreeable Language explores a possible solution -- through linguistics, the study of human language. A sub-field of linguistics is the study of language structure, an enterprise which is self-contained and relies on no information outside of language and speaker intuitions. But this independence from reality may make linguistics the right tool for the detection of reality. If patterns of untruth leave their mark in language itself, linguistic techniques would be the way to reveal them. That could provide an escape route out of the matrix. At the very least, students in this course will learn basic methods for interrogating the language we use to get through to one another, that is, basic methods for doing linguistics.

80-201 Knowledge and Justified Belief
Intermittent: 9 units
Knowledge acquisition is central to the university's mission. The sciences seek knowledge of nature. Statistics concerns methods for finding and establishing scientific knowledge. Machine learning concerns the automated generation of knowledge. Database theory concerns the maintenance of knowledge. But then what are knowledge, justified belief, truth, and evidence, and how do all of those concepts fit together? The branch of philosophy that studies those questions is called epistemology, which just means "study of knowledge". This class confronts the central epistemological questions. Topics include the analysis of knowledge and justification (what are they?), skepticism (the justifiability of beliefs that go beyond the data available), and the relationship between knowledge and deductive logic (are the consequences of knowledge knowable?). The proposed answers involve a subtle interplay of logic, probability, causation, and counterfactual reasoning. The course is self-contained, so there are no prerequisites.

80-208 Critical Thinking
Intermittent: 9 units
This course is an introduction to practical reasoning. The course will contain an elementary introduction to concepts important for reasoning and decision making, such as validity, probability, and utilities. Students will extensively practice critically analyzing and evaluating a wide variety of arguments found in newspapers, magazines, and elementary accounts of scientific reasoning. In order to help students develop the skills to analyze and evaluate arguments, the course will introduce several software packages recently developed at CMU that help students diagram arguments and causal reasoning; these packages have been shown to improve students critical reasoning skills. In addition, students will learn about a wide variety of statistical, logical, psychological, and causal fallacies that are used to mislead people.

80-210 Logic and Proofs
All Semesters: 9 units
Logic and Proofs is a web-based course and introduces students to central issues in modern logic. It is designed for individual learning with rich interactive environments and does not require instructor or teaching assistance. The material is presented on-line, and most exercises are done on-line as well. Readings of historical and philosophical character complement the core content. This on-line course is supplemented, indeed given additional grounding, by weekly meetings in very small groups. There, we have collaborative reviews, substantive discussions and critical reflections. The central question of the course is this: How can we analyze the structure of rational discourse or, more specifically, the logical structure of argumentation? An answer to this question requires: (i) uncovering the logical form of statements; (ii) defining the correctness of logical steps; (iii) formulating inference rules for the logical forms; (iv) designing strategies for argumentation with the inference rules. The course takes these steps for both sentential and quantifiational logic.

Course Website: https://oli.cmu.edu/courses/logic-proofs/

80-211 Logic and Mathematical Inquiry
Fall: 9 units
Since ancient times, mathematical arguments have served as a paradigm for rational inquiry. We will study fundamental mathematical concepts and informal proofs as they occur in everyday mathematics. We will also use the methods of mathematical logic, which provides formal symbolic languages, to help us understand the structure of a mathematical argument. Finally, we will make use of a new computational "proof assistant," called Lean, to develop fully rigorous, machine-checked proofs.

80-212 Arguments and Logical Analysis
Intermittent: 9 units
Are there rational methods that can further our knowledge? The notion of rational inquiry presupposes that there are appropriate methods for the pursuit of knowledge. In this course, we will investigate the means by which a successful argument justifies its conclusion, as well as various subtle ways in which other arguments fail. The course will explore the use of logic as an instrument in the study of arguments and reasoning, and it will serve as a gentle introduction to the elementary concepts of formal logic. We will take a historically informed approach to studying logic and argumentative fallacies, and we will discover that logical tools and methods are useful for constructing and analyzing arguments in all disciplines, from philosophy and history to psychology and physics. Our goals are to acquire a solid grasp of some fundamental tools of modern logic, and learn how to use them to make our thinking and writing clearer, more precise, and more critical. To this end, our coursework will consist in homework and exams on topics in logic, as well as writing assignments on a variety of topics. This course is intended for students from any discipline who would like to improve their writing and critical thinking skills, as well as students who are interested in learning logic without having had prior contact with the subject.

80-220 Philosophy of Science
Intermittent: 9 units
In this course, we will examine some historical case studies (e.g., the Copernican revolution in astronomy) against which we will assess views pertaining to the significance, justification, and production of scientific knowledge. For example, should scientific theories be understood literally or as computational devices for deriving new predictions? How can universal conclusions ever be justified by a finite data set? Does explanation contribute to a theory's confirmation by the evidence? Does science aim to find the truth? Is probability in the world or only in our minds? Is explanation a matter of finding causes or are causes whatever it is that explains? Is scientific rationality objective or culture-relative?

80-221 Philosophy of Social Science
Spring: 9 units
This course will explore various philosophical issues germane to social science. The central question of the course asks whether we can use traditional scientific tools to understand social phenomena, e.g. social inequalities, violence, changes in politics, in the same way that we use them to understand natural phenomena, e.g. gases, lasers and planetary orbits. Some of the more specific questions we address: Because humans possess free will and act with intentions while light rays and planets in motion do not, are we forced to use logically different species of explanations in the two cases? How can we explain social institutions that depend upon cooperation? Whereas natural scientists actively conduct experiments, social scientists can often only collect statistical and qualitative data. Does this difference prevent social scientists from inferring causal relations? Is our understanding of social phenomena always value laden?
80-226 Revolutions in Science
Fall: 9 units
Science is an ever-changing enterprise. Most scientific advances, though significant, occur within a stable framework of accepted theories and data. A few episodes of change in the history of science involve discarding and replacing fundamental theories of the world. These are often accompanied by significant changes in the vocabulary in which those theories are expressed, the tools used by scientists, the phenomena on which scientists focus, and the kinds of explanations they consider acceptable. A very small number of these episodes change the way humanity views its ability to know the natural world and its place in the universe. The latter two kinds of change in science have often been called "scientific revolutions." We will focus on three such radical transformations: The "Copernican Revolution" (or "the Scientific Revolution") of the 16th and 17th centuries, the Darwinian revolution of the 19th century, and the quantum revolution of the late 19th and 20th centuries. This course has two intertwined components: history of science and philosophy of science. In the historical component, we will examine in some detail the three major scientific revolutions. The philosophical components will help us understand the reasoning involved in scientific theory change. This course does not require detailed knowledge of any of the sciences used in examples of revolutionary change.

80-234 Race, Gender, and Justice
Intermittent: 9 units
Race and gender, along with their interfaces and interactions with such other social identities as sexuality, (dis)ability, and class, structure our experience of almost every aspect of our social and political reality. Philosophers approach these kinds of social identities from a variety of perspectives. They ask what these kinds of social categories really are, what they mean for the ways we live our lives and the ways we perceive and understand the world, how they have (mis)informed our theoretical and practical understanding of the nature of justice and political power, and what is owed to those affected by racial and gendered injustice. This course explores these topics, drawing on tools and perspectives from epistemology, ethics, and especially social and political philosophy.

80-244 Environmental Ethics
Fall: 9 units
In this class, we'll try to figure out what obligations we might have to the natural environment and the non-human living beings within it, as well as what justice requires of us in our use of natural resources given the needs of other human beings. Among other things, we'll spend considerable time on animal ethics: what moral obligations do we have to non-human animals? Is it morally OK to eat them? Does a dog count (morally speaking) as much as a human? Does a factory-farm chicken count as much as a wild endangered tiger? Then, given that many of the most pressing environmental problems like climate change are collective action problems, we'll consider why these problems are so sticky, what obligations we have as individuals in dealing with these problems, and what a just collective solution might look like. To that end, we'll examine the processes fueling climate change, we'll look at who is responsible for these processes, and we'll try to determine whether any current proposal to deal with climate change is an effective, just response to the problem.

80-245 Medical Ethics
Spring: 9 units
This course provides a detailed introduction to core ethical issues in medical ethics and public policy. Topics include: the moral responsibilities of health care providers to patients and various third parties such as the government or insurance companies, the status of health as a social good, questions of justice in access to health care, and questions of individual liberty and social responsibility at the ends of life including issues such as cloning, abortion, physician assisted suicide, and the definition of death. We will also examine specific ethical issues in the conduct of medical research and look at the impact of technological innovation on our notions of health, disease, life, death, and the family. While the course engages such substantive ethical issues it also attempts to sharpen students' skills in practical reasoning through argument analysis, analogical reasoning, and the application of theory and principles to particular cases.

80-246 Moral Psychology
Intermittent: 9 units
In this course you will read cutting-edge scientific work on morality and you will learn to interpret it in light of recent lessons from biology and computer science. This course will also introduce you to distinctions that philosophers have found useful for moral-philosophical and meta-ethical theorizing. Topics that we may discuss include: the psychology of normative ethics; moral emotions (e.g., disgust, guilt, shame, pride, etc.); the origins of morality in human and nonhuman animals; moral development in babies and children; the role of moral judgment in folk theorizing; and mathematical models of morality inspired by insights from machine learning. However, this course is exploratory and designed to be open-ended. I hope and expect that students will help to determine what we read and discuss.

80-249 AI, Society, and Humanity
Fall: 9 units
AI and robotic technologies are developing rapidly and are increasingly incorporated into decisions, practices, and activities that impact individual and social interests. To ensure that these technologies advance meritorious goals without undermining important values or relationships, stakeholders must be able to understand the diverse ways in which new technologies can impact the lives of individuals and communities, the diverse dimensions on which such impacts can be evaluated and measured and where in the lifecycle of product development these various impacts might be anticipated and addressed. Through a series of case studies of current or near-future AI and robotics technologies students in this course will explore frameworks for assessing, evaluating and regulating novel technologies with the goal of ensuring that they support and advance human interests and social values.

80-250 Ancient Philosophy
Fall: 9 units
This course will cover Ancient Greek philosophy from the pre-Socratics to the later Hellenistic writers. We will prepare the background for Socrates and Plato by studying major Presocratic philosophers such as the Milesians, Heraclitus, and Parmenides, and then dive in to a careful study of some of the central works of Plato and Aristotle. A key theme of the class will be the way in which Socrates, Plato, and Aristotle sought to define philosophy in opposition to sophistry, and how the lessons learned from their confrontation with sophistry informed their ethical and metaphysical thought. The final sections will discuss post-Aristotelian movements such as Epicureanism, Skepticism, and Stoicism.

80-251 Modern Philosophy
Spring: 9 units
This class will focus on the history of Western philosophy in the modern period, with special emphasis on the "early modern" era of roughly 1600-1800. Massive upheavals and conflicts in science, politics, and religion fueled attempts to find new ways of making sense of the world, and we will try to situate our philosophers within this rapidly evolving intellectual context. In particular, we will examine the impact of these changes on two subfields of philosophy: metaphysics (the study of the nature of reality, distinguishing it from mere appearance), and epistemology (roughly, the study of knowledge itself). We will ask, and attempt answers for, questions like: What is knowledge, can we achieve it, and if so, to what extent? To what extent, if any, can our most basic scientific instruments, the human senses, lead us to the true nature of the world? These questions will unavoidably send us down paths into other subfields, like philosophies of mind, of free will, of ethics, and of religion. After reading early modern philosophers like René Descartes, Princess Elizabeth of Bohemia, John Locke, David Hume, and Immanuel Kant, we will turn to some more recent work in the modern and contemporary eras to see what lessons (if any) were learned, and what new approaches (if any) have been taken in the quest for knowledge and reality.

80-252 Kant
Intermittent: 9 units
Immanuel Kant was a CMU sort of person. He was an enthusiastic follower of Isaac Newton, and his approach to fundamental philosophy was: "what would robotics be like from the viewpoint of the robot?" From that starting point, he investigated what would have to be the case for the robot to know anything about its environment. The resulting "critical philosophy" defined the relevant philosophical vocabulary for generations of prominent mathematicians and scientists into the 20th century, and is pivotal background both for both the "analytic" and the "continental" schools of philosophy. This course starts with essential background reading in pre-Kantian, early modern sources, including Descartes. Then it focuses on a detailed reading of Kant's Critique of Pure Reason and related texts. Course requirements include written answers to reading questions and two short paper projects. There are no prerequisites.
80-253 Continental Philosophy
Intermittent: 9 units
This course provides students with an overview of key movements in European Philosophy. The historical background covers Descartes, Kant, Kierkegaard, and Nietzsche. The central tenets of phenomenology and existentialism (e.g., intentionality, Being-in-the-World, Bad Faith) will be discussed in the context of selected works from Husserl, Heidegger, Sartre and Merleau-Ponty. The course will conclude with the background for and current work of Habermas.

80-254 Analytic Philosophy
Intermittent: 9 units
This course examines the revolutionary impact of philosophy at the turn of the 20th century on contemporary thought and progress. By the 1920s some scientists and philosophers became hopeful that the end of the long tradition of philosophical deadlock was finally within reach. Buoyed in particular by Einstein's theory of relativity and the invention of modern logic, they created a new kind of philosophy with the goal of applying logical and empirical methods to philosophical problems. This new approach led to new puzzles and paradoxes, along with a focus on the age old question of what can be known and what is meaningful. The modern fields of linguistics, cognitive science, and information and computer sciences all owe a debt to these sources, as does of course contemporary philosophy. Our quest will be to understand both what authors like Frege, Russell, and the Vienna Circle were up to in the first place, and how their work contributed to the world we live in today.

80-255 Pragmatism
Intermittent: 9 units
American Pragmatism represents an energetic attempt to bridge the divergent cultures of science and the humanities. The movement's founder, C.S. Peirce, was trained in chemistry and worked as a physicist, but he was also deeply concerned with the contemporary philosophical portrayal of science, which distinguished sharply between theoretical knowledge and practice. Peirce responded by constructing a comprehensive philosophy emphasizing the scientific importance of community, fallibility, and action. Pragmatism was also developed and vigorously popularized by William James, who aspired to be a painter and ended up as an acknowledged founder of modern empirical psychology. James extended Peirce's position by defending the role of values in even the purest of empirical sciences. John Dewey, who is also well-known for his role in education, interpreted science as an evolving social system and developed a theory of aesthetics based on what we now call the psychology of problem solving. The pragmatists made and continue to make lasting contributions to modern statistics, logic, and social science and their emphases on community, fallibility, action, and value in science are still of primary importance in philosophy and in the ongoing dialogue between the scientific and humanistic cultures.

80-256 Modern Moral Philosophy
Intermittent: 9 units
This course will follow moral theory through the modern era (roughly 1600-1900), with special emphasis on the works of Hobbes, Hume, and Kant, as well as the development of utilitarianism. Since moral theorizing was only one part of these thinkers' larger systems of philosophy, it cannot be fully separated from questions of metaphysics and epistemology (e.g., free will, determinism, materialism, etc.), and we'll spend some time situating their ethical thought within their larger projects. In doing so, we'll also examine these theories within the context of the rapidly changing social, political, and scientific landscape of the modern period.

80-257 Nietzsche
Intermittent: 9 units
During his life in the late 19th-century, Friedrich Nietzsche was a relatively obscure German philosopher. Since his death, however, he has become deeply influential and well-known, and was a source of inspiration for many important 20th-century thinkers. Despite this popularity, Nietzsche's philosophy remains relatively mysterious, and often misunderstood. Much of his writing consisted of aphorisms, rather than more traditional prose and arguments, and many of his positions seem to contradict one another. This course will cover a broad range of Nietzsche's writings, focusing on such central concepts as the will to power, eternal recurrence, and the oft-misunderstood Ubermensch ("overman"). Throughout, we will focus on developing a consistent interpretation of an enigmatic philosopher whose views have been mischaracterized and misappropriated throughout the past century.

80-261 Experience, Reason, and Truth
Intermittent: 9 units
A central issue in Western philosophy has been whether reason or experience (or some of both!) provides the foundations for human knowledge. This course explores that question by looking at various "empiricist" vs. "rationalist" debates from the 17th century to the present day. We will focus on the problems encountered in trying to give an adequate account of the our knowledge of the external world, the structure of our minds, and the nature and limitations of human knowledge. The scope of our investigation will extend to the nature of mathematical knowledge, to "thought experiments" in both science and philosophy, and to "nativism" vs. "empiricism" issues in contemporary cognitive science and moral theory. The course has two main goals: (1) to study key metaphysical and epistemological issues surrounding the nature of human knowledge and (2) to help improve our analytical and critical skills by extracting and evaluating various relevant philosophical arguments.

80-270 Problems of Mind and Body: Meaning and Doing
Fall: 9 units
Central to our existence is meaning and our responses to it. We believe and desire things and on the basis of these attitudes, we make things happen. How can meaning exist in a seemingly mindless world? How can the world give rise to a mind capable of agency? This course tackles the mind body problem in respect of explaining meaning and human action. We tackle philosophical problems with serious engagement with empirical work from psychology and neuroscience. Students taking the course will tackle these problems with emphasis on developing analytical abilities.

80-271 Mind and Body: The Objective and the Subjective
Fall: 9 units
This course is about the subjective and the objective. "Subjective" captures the distinctive features that characterize what it means to be a psychological subject. This includes the power to represent, to think, feel, sense and in general to be conscious. Subjective features seem radically different from the physical world of matter and forces, a world that seems meaningless, unthinking and nonconscious. How can the subjective be rooted in the objective? We address this central philosophical problem by engaging philosophy with science. In this course, we will investigate thinking, sensing, imagining, dreaming, hallucinating, mindfulness and self-knowledge. As a result, we will explore how the subjective might be the objective. Students will develop analytical techniques such as conceptual analysis and argument analysis.

80-275 Metaphysics
Intermittent: 9 units
The topical agenda of this course will vary. Typical topics include the problem of personal identity, the nature of human freedom, the nature of the self, the nature of reality and being, the nature of causality, and the question of whether solutions to such problems can be given. Classical as well as contemporary philosophical texts will be studied. For Spring 2011: Issues we will consider, in no particular order, include: Do properties exist? Why should you think there is an external world? What is a number? Why should you think other people have mental states? What are natural kinds? What constitutes the identity of things through time? What constitutes the identity of persons through time? What does determinism mean? Is there freedom of the will? What is possibility? What is necessity? Are there other possible worlds? When does one event cause another, and what does that mean? What could a deity be, and should you think there is one?

80-276 Philosophy of Religion
Intermittent: 9 units
While many interesting questions about religion are belief-specific, we will strive in this course to keep a global perspective. We will begin by considering a concept at the center of Western religion -- God -- as it presents itself in various traditions. We will then move to consider major Eastern religions, with a focus on their influence on philosophical thought. In both of these studies, we will emphasize the relationship between language and religion. We will conclude the course by considering commonalities between Eastern and Western religious thought. The student should leave the course with 1) the tools to consider religious text and rhetoric philosophically, and 2) a sharpened idea of what 'religion' is (though this might differ from my own).
80-280 Linguistic Analysis
Spring: 9 units
How do physical events (sounds) or physical objects (marks on paper) create or transmit meaning? Linguistic values are assigned to sounds and marks, based on specific physical features, creating phonemes and graphemes. Juxtapositions of phonemes and graphemes create morphemes, minimal units that hold meaning, with syntax arranging morphemes into sentences, minimal units of information. Further structural changes change the mood of a sentence and give it new function - as a request for information, demand for action, presentation of alternatives, and so on. The goal of this course is to investigate the structure of basic sentences and then the changes to structure by which communicative function is realized. Building on material taught in Nature of Language, this course looks in detail at the syntax of human languages, taking into account cross-linguistic variety.
Prerequisite: 80-180

80-282 Phonetics and Phonology I
Fall: 9 units
This course aims to provide students with practical tools for the study of speech sounds. The first step in this analysis is isolating the speech sounds themselves, for any particular language. Following this, the relation between the articulatory features of sounds and their acoustic properties is examined using spectrograms and other devices. Basic phonological notions are covered, tracing their development in the twentieth century up through optimality theory. In optimality theory, contrast and allophonic variation are explained in terms of an input-output device which selects the most harmonic candidate still faithful to phonemes in the input. The course should be relevant not only to linguistics students, but to students of language generally, with applications to sociolinguistics, child language development, speech recognition technologies, and the study of foreign languages.
Prerequisite: 80-180

80-283 It Matters How You Say It
Spring: 9 units
Why do languages give us multiple ways to say the same thing? Given that in English we can say "My dog ate my homework," why do we sometimes prefer "My homework got eaten by my dog"? Why do we sometimes choose to refer to someone with just a pronoun ("he"), and sometimes choose their full name ("Charles Dickens")? What's the difference between telling someone: "This expensive coffee is tasteless," or telling them: "This tasteless coffee was expensive"? This course is about the choices that languages give us for conveying a particular message, and the communicative effects of those choices. We will see that it is both the words you use and the way you put them together that determines the total communicative effect of your utterance. While the course will focus on English, students will have an opportunity to work on another language of interest in their final project.

80-284 Invented Languages
Fall: 9 units
Language is normally something that develops and and changes organically within human communities, without much in the way of organized design or invention. Over the centuries, however, many have succumbed to what J. R. R. Tolkien called the "secret vice" of language creation. The purposes of these invented languages have been diverse. Some, like Tolkien's Elvish languages, Okrand's Klingon, and Peterson's Dothraki and Trigedasleng have been designed for artistic or entertainment purposes: they have set out to be "natural" languages within fictional worlds. Others, like Zamenhof's Esperanto, Brown's Loglan, and Elgin's Láadan have tried to address perceived inadequacies of the natural languages that their creators saw in the world around them. The of study language invention is thus both the study of a distinctive art form, and an exploration of the history of how people have thought about language in different ages and societies.
In this course, we will explore the linguistic considerations involved in language invention, and the linguistic lessons of the history of invented languages, with a particular emphasis on applying these insights to our own language invention projects. Over the course of the semester, students will be expected to develop invent their own languages, and to complete various shorter assignments to supplement relevant ideas and skills. This course does not assume any background in linguistics, and is intended to accommodate both newcomers and advanced students.

80-285 Natural Language Syntax
Spring: 9 units
This course is intended to provide an introduction to the methods of syntactic analysis and the study of syntactic structure. A primary theme of the course is the the notion of syntactic constituency: how can we tell if a language treats a given sequence of words as single grammatical unit? Do all aspects of syntax manipulate the same kinds of structural units? How do other syntactic relations connect with constituent structure? To the extent that there is mismatch between different notions of syntactic structure, how can it be reconciled within a theory of grammar? These questions are engaged in through the diagnostics and techniques of modern syntactic analysis and argumentation. Those tools will allow us to explore the striking ways in which syntactic theory unifies diverse grammatical phenomena in terms of a common notion of phrase structure. The course complements 80280, Linguistic Analysis, building on but not presupposing syntactic analyses developed in that class.
Prerequisites: 80-284 or 80-180

80-286 Words and Word Formation: Introduction to Morphology
Fall: 9 units
How many words do you know? Is 'gonna' one word or two? How many meanings does 'unlockable' have? If someone can be 'inept', why can't they be 'ept'? In this course we study the linguistics of words and word formation, known as morphology. We begin by asking what a word is, about the internal structure of words, and how new words are formed. Throughout, we will consider these questions from a cross-linguistic perspective, looking at morphological data from a wide range of languages. We will also consider how morphology interacts with other subfields of linguistics, including phonology, syntax and semantics. Finally, we will survey morphological questions from the perspectives of language acquisition, psychology, and cognitive science.
Prerequisite: 80-180

80-287 Language Variation and Change
Spring: 9 units
This course explores language variation across space and time. Our experience of language is full of direct and indirect evidence of language change and variation, and of the ways that these interact and intersect with other historical and social phenomena. How do languages change over time, and what kinds of factors influence this change? How do we determine whether, say, Farsi and Nepali (or Farsi and English) were at some point in the past the same language, before different changes took them in different directions? If they are, how do we investigate what that past language might have sounded like? What are the sources of variation within and between languages, and how can we investigate the nature of this variation? How can an understanding of language change help us to make sense of language variation, and how can an understanding of language variation help us to make sense of language change? How do issues of social status and political power affect language variation and change? What happens when languages come into contact? How can linguistic theory inform the study of variation and change, and what insights can the study of these phenomena contribute to linguistic theory? This course is intended to provide students with the tools to begin to explore and address these kinds of questions.
Prerequisite: 80-180
80-288 Intonation: Transcription and Analysis
Spring: 9 units
Intonation is the melody of speech: how a speaker's pitch changes over the course of an utterance, along with the placement of emphasis, or sentence-level stress. Intonation and stress contribute to the interpretation of utterances in multiple ways. For example, the questions "Did BOB go to the store?" and "Did Bob go to the store?" contain the same words, but request different information. Similarly, whether the sentence "Bob went to the store" is interpreted as a statement or a question, and whether as expressing certainty or uncertainty on the part of the speaker, depends on its intonation. Features of intonation can also convey information about the speaker's attitudes and affect: sarcasm and irony, for example, may be signaled by intonation. The goal of this course is two-fold. First, students will learn about the phonetic correlates of intonation and stress, and learn how to analyze intonation as a system of high and low tones, using the intonation transcription system ToBI. This will enable students to accurately describe the intonation pattern of an utterance. Second, students will learn how intonation is used to convey semantic and pragmatic information. The course will focus primarily on English, but other languages will be explored to serve as a basis of comparison. The course will be of interest to students interested in learning some of the intricacies of face-to-face linguistic communication. Students in the departments of English, Modern Languages, Language Technology, Human-Computer Interaction, and Psychology will find material relevant to their major topics. The course serves as an elective for the Linguistics Major, and is a natural companion to other courses on the expression of linguistic meaning: Meaning in Language, Language in Use, and Syntax and Discourse. The course requires basic background in phonetics.
Prerequisites: 80-180 or 80-488 or 80-284 or 85-385 or 85-356

80-305 Decision Theory
Fall: 9 units
This course is an introduction to formal models of choice and decision-making. We begin by examining choice under uncertainty, developing both qualitative and quantitative models of preference. We then expand our analysis to take into account uncertainty, and the von Neumann-Morgenstern theory of expected utility and Savage's classic axioms. Empirical challenges to models are emphasized throughout, in response to which we will consider a variety of alternative representations of uncertainty (e.g., Dempster-Shafer belief functions, non-unique probability measures) and preference (e.g., framing effects, prospect theory).

80-310 Formal Logic
Spring: 9 units
Among the most significant developments in modern logic is the formal analysis of the notions of provability and logical consequence for the logic of relations and quantification, known as first-order logic. These notions are related by the soundness and completeness theorems, which state that a logical formula is provable if and only if it is true under every interpretation. This course provides a formal specification of the syntax and semantics of first-order logic and then proves the soundness and completeness theorems. Other topics may include: basic model theory, intuitionistic, modal, and higher-order logics.
Prerequisites: 80-211 or 15-251 or 21-127 or 80-210

80-312 Mathematical Revolutions
Spring: 9 units
Mathematics is a central part of our intellectual experience. It is connected to sophisticated philosophical perspectives, say, in the work of Plato, Descartes, Leibniz, Kant, as well as in contemporary analytic philosophy; it is equally connected to fundamental views in the sciences, say, in the work of Ptolemy, Galileo, Newton, Einstein, as well as in contemporary cosmology. The common view that mathematics - if not directly "static" - is evolving in a linear fashion, does not withstand historical scrutiny. Indeed, there are many dramatic conceptual changes concerning the very nature and object of mathematics.

80-314 Causal Discovery, Statistics, and Machine Learning
Spring: 9 units
Statistics and Machine Learning have made tremendous strides in recent years in solving a wide variety of regression and classification problems. However, causal discovery problems (i.e. discovery of which variables are affected by a given variable that undergoes change due to an external intervention, either man-made or natural, and to what extent other variables are affected by such a change) are distinct and more difficult problems. Causal discovery problems arise not only in scientific contexts (e.g. discovering which genes regulate which other genes) but also in some machine learning contexts (e.g. transfer learning problems). This course will (i) describe how causal discovery problems differs from regression and classification problems in goals, methods, and fundamental assumptions, (ii) describe recent advances in modifying machine learning and statistical algorithms to deal with causal discovery problems involving such difficulties as latent confounders, missing data, selection bias, etc., and (iii) discuss the outstanding problems in causal discovery and are future directions the field might take. Students should have taken at least one course in statistics or machine learning, or obtain the permission of the instructor.

80-315 Modal Logic
Fall: 9 units
Standard logical languages can express negation ("not p"), conjunction ("p and q"), material implication ("if p then q"), quantification ("for all x, p(x)"). etc. But they don't directly capture statements like the following: "Alice knows p." "Henceforth, it will be the case that p." "It ought to be the case that p." "If it had been the case that p, it would have been the case that q." "Everybody knows p." "Everybody knows that everybody knows p." "Indefinitely often in the future, p will be true." "After an announcement of p, it will be the case that Alice knows q." "If p is not permitted, then you ought to know that p is not permitted." etc. Modal logic is a very general framework for systematically reasoning about statements like these. This course is an introduction to mathematical modal logic and its applications in philosophy, computer science, linguistics, and economics, with emphasis on epistemic interpretations (i.e., logics for representing and reasoning about knowledge/belief). We begin with a rigorous development of propositional modal logic: the basic language, interpretation in relational structures, axiom systems, proofs, and validity. We prove soundness and completeness of various systems using the canonical model method and study model equivalence and expressivity results. We also consider topological semantics, alternative to relational semantics, and investigate the connection between the two. In the latter part of the course we turn our attention to more specialized logical systems and their applications, as determined by the interests of the class. Topics may include: quantified modal logic, multi-agent systems and the notion of common knowledge (with applications to game theory), temporal and dynamic logics for (nondeterministic) program execution, logics for reasoning about counterfactuals, public announcement logic, deontic logic, intuitionistic logic, and others.
Prerequisites: 15-251 Min. grade C or 21-127 Min. grade C or 80-211 Min. grade C or 80-210 Min. grade C or 21-128 Min. grade C or 80-212 Min. grade C or 80-284 Min. grade C or 85-385 Min. grade C or 85-356 Min. grade C

80-316 Logic and AI
Intermittent: 9 units
In this course, we will study logical systems that are relevant to, and motivated by, research in artificial intelligence. We will see how key ideas and advances in logic have found (and continue to find) natural applications in AI. More generally, we will see how logic and AI can benefit, and historically have benefited, from each other. A central aim of this course is to understand how logical languages of varying expressive power can be put to use in AI as a tool for representation and reasoning. Some of the topics that we will be focusing on are (1) non-monotonic and default logics, (2) modal logics for reasoning about knowledge/belief, temporal structures, and computation, (3) proof theory and automated reasoning, (4) logics of graphical causal models and counterfactuals, as well as (5) elements of probabilistic programming and computable probability theory.
Prerequisites: 80-310 or 80-610
A unifying theme is that strong definitions of successful learning imply reflection and exercises providing concrete experience with ML methods. This involves both philosophical foundational issues underlying ML research. It involves both philosophical, the foundations of statistics, the philosophy of science, and epistemology, spontaneously for the reflective ML researcher, but they also cross over into circumstances of training? Can learning be guaranteed to succeed by causal relations? Are predictions expected to be reliable beyond the narrow goal prediction or truth; control or understanding; actual fact or necessary estimating or predicting quantities in nature (frequentist statistics)? Is the consistency among our beliefs (Bayesian statistics), or is it a matter of questions. What, exactly, is the goal of learning? Is it maintenance of artificial intelligence. The very idea raises some natural, fundamental goal of machine learning (ML), which is arguably the most successful branch of modern causality research, focusing particularly on how to discover causal relations from observational data and how to infer the causal effect of one variable on another. Thinking more broadly, causal analysis is a particular branch of unsupervised multivariate analysis. Accordingly, this course also provides a big picture of the foundations of causation and multivariate statistical analysis problems including factor analysis, principal component analysis, and independent component analysis, and formulate their assumptions, develop their solutions, and study their connections with causal analysis. Finally, we investigate whether a new approach helps in solving advanced machine learning or artificial intelligence problems, including transfer learning, image-to-image translation, reinforcement learning, and unsupervised deep learning.

80-325 Foundations of Causation and Machine Learning
Fall: 9 units
How can we define causality? Does smoking cause cancer? Can one find causality from observational data without temporal information? In our daily life and science, people often attempt to answer such causal questions for the purpose of understanding, proper manipulation of systems, and robust prediction under interventions. In the past decades, interesting advances were made in machine learning, philosophy, statistics, and economics for tackling long-standing causality problems, and a number of researchers have been recognized with the Turing Award (to Pearl in 2012) the Nobel Prize (to Granger in 2003 and to Sims in 2011). This course is primarily concerned with historical and technical developments of modern causality research, focusing particularly on how to discover causality from observational data and how to infer the causal effect of one variable on another. Thinking more broadly, causal analysis is a particular branch of unsupervised multivariate analysis. Accordingly, this course also provides a big picture of the foundations of causation and unsupervised machine learning. We start with unsupervised learning and multivariate statistical analysis problems including factor analysis, principal component analysis, and independent component analysis, and formulate their assumptions, develop their solutions, and study their connections with causal analysis. Finally, we investigate whether a new approach helps in solving advanced machine learning or artificial intelligence problems, including transfer learning, image-to-image translation, reinforcement learning, and unsupervised deep learning.

80-326 Epistemology of Machine Learning
Intermittent: 9 units
Learning is hard! Programming a computer is also hard. Better that computers learn on their own from data. A goal of machine learning (ML), which is arguably the most successful branch of artificial intelligence. The very idea raises some natural, fundamental questions. What, exactly, is the goal of learning? Is it maintenance of consistency among our beliefs (Bayesian statistics), or is it a matter of estimating or predicting quantities in nature (frequentist statistics)? Is the goal prediction or truth; control or understanding; actual fact or necessary causal relations? Are predictions expected to be reliable beyond the narrow circumstances of training? Can learning be guaranteed to succeed by a specified time? Does success entail some detectable mark or sign of success that can be used to terminate the learning procedure? What roles do causality and simplicity play in learning, and how? Those questions arise spontaneously for the reflective ML researcher, but they also cross over into the foundations of statistics, the philosophy of science, and epistemology, the traditional philosophical study of the nature of knowledge and justified belief. This class provides an introduction to the relevant philosophical foundational issues underlying ML research. It involves both philosophical reflection and exercises providing concrete experience with ML methods. A unifying theme is that strong definitions of successful learning imply correspondingly strong limits on what can be learned.
80-365 Ramsey
Intermittent: 9 units
Frank Ramsey's untimely death in 1930, at the age of 26, marked the loss of a versatile and original thinker. During his short life, he made decisive and influential contributions to philosophy, mathematics and economics. The entire core of Ramsey's philosophical and scientific work consists of no more than 15 papers; in all cases they are remarkable essays that changed the intellectual topics they touched. This course will explore Ramsey's seminal contributions to probability and decision theory, philosophical and mathematical logic, the foundations of mathematics, metaphysics, and the philosophy of science. We will read some of Ramsey's original papers as well as more recent work inspired in response to, or as an elaboration on, Ramsey's views. We will see how Ramsey laid the foundations of the theory of subjective probability and decision theory, offered one of the first formulations of a deflationary theory of truth, and inspired contemporary work in philosophical logic (particularly on the logic of conditionals). We will explore Ramsey's influential work in the philosophy of science - his accounts of laws, causality, and the nature of scientific theories - as well as his mathematical contributions to logic and (what is now known as) Ramsey theory. By examining Ramsey's contributions and their impact, the course will give a sense of their important position as quintessential examples of work in the analytic tradition, demonstrating the intellectual fruitfulness of interdisciplinary inquiry into foundational questions and of mathematically informed philosophy.

80-380 Philosophy of Language
Intermittent: 9 units
Questions about language, meaning, and communication have a central place in both the history of analytic philosophy and the life of human societies. What do our words mean? What do we do by speaking them? What is the relationship between what our words literally mean and what we use them to communicate? What is it for a statement to be true but misleading? In what sense is it possible to experience a distinctively linguistic injustice? Should philosophers approach ordinary language as a cause of needless confusion, an indispensable source of insight, or both? In what ways is the study of language about the individual mind, in what ways is it about the speaker community? In spring 2020 this course will explore some major themes from the last century's debates in the philosophy meaning and communication, with attention to how these topics connect with social and political questions and with work in feminist philosophy. Students who do not meet the prerequisites but have an interest in the topic are strongly encouraged to reach out to the instructor about exceptions.

80-381 Meaning in Language
Fall: 9 units
One of the more elusive topics in the linguistics of natural language is meaning. This is the field of semantics. A key question to answer in semantics is what meaning even is. In this course, we will give an answer to this question, starting with the meaning of basic sentences. These are sentences that describe what is the case. From there, we break sentence meaning into the meaning of words. In the other direction, we consider the meaning of non-basic sentences such as questions and imperatives. We also consider the meaning of complex sentences and sentences that express irrealis. That starts with the subject of negation, with sentences that describe what is not the case. From there we move to sentences used to talk about what could be the case, what will be the case, what could've been the case, and what could never have been the case. A peculiarity of semantics is that the abstract questions we ask yield answers that are highly concrete and practical. But that only makes sense given that language permeates every human activity and it really matters what we mean by what we say. Prerequisite: 80-180

80-382 Phonetics and Phonology II
Spring: 9 units
This course is a continuation of Phonetics and Phonology I (80-282), and is designed to expand upon the phonetic and phonological skills and knowledge developed in that course. Students will carry out a phonetic study (either acoustic or perceptual) designed by the instructor; the particular topic varies from semester to semester. As co-researchers, students will be involved in all aspects of data collection and analysis. Lessons in phonetics will be designed to train students on the necessary skills and concepts required, including understanding the articulatory, acoustic, and perceptual correlates of the phenomenon under investigation, as well as data analysis and interpretation of the results. A presentation session will be organized for the end of the semester. In tandem with the phonetic study, a related phonological phenomenon will be investigated throughout the semester. This phenomenon will be explored by using a set of case studies that can be investigated through various phonological and psycholinguistic perspectives. We will cover major developments in phonological theory, including SPE-style features, feature geometry/ autosegmental phonology, and Optimality Theory. We will also consider these phenomena in light of more recent approaches to phonological representation, including Exemplar Theory and Articulatory Phonology. Assessment of phonetics will primarily come from the research project and in-class lab work, but will be supplemented with quizzes to ensure that core concepts are acquired. Assessment of phonology will primarily come from problem sets. Students will finish this course with a solid understanding of how to do phonetic research, and an appreciation of how various theoretical frameworks have attempted to account for phonological phenomena.

Prerequisites: 80-180 and 80-282

80-383 Language in Use
Fall: 9 units
In ordinary conversation, what a speaker conveys by the utterance of a sentence may go beyond, or be quite different from, the meaning that could be assigned to the sentence or expression that they use without consideration of the context in which it occurs. For example, the sentence "I have homework" means one thing; but it conveys something more when uttered in answer to the question "Do you want to go see a movie tonight?" In this course, we explore how the systematic study of linguistic meaning can be expanded from the domain of the sentence to the domain of connected, multiparty discourse. This involves taking into account the contributions of context, and of speaker and hearer's beliefs, goals and intentions, to the construction of meaning. This course is one of the set of courses on language and meaning offered by the Program in Linguistics, including in addition to this: 80-283 It Matters How You Say It, 80-285 Intonation, and 80-381 Meaning in Language. Each of these courses can be taken independently; as a set, these courses provide a comprehensive introduction to contemporary approaches to natural language semantics and pragmatics.

Prerequisites: 80-100 or 80-180

80-384 Linguistics of Turkic Languages
Intermittent: 9 units
In this course we look at languages from within a single language group, Turkic. Turkic languages are spoken across continental Asia and include such languages as Turkmen, Tatar, Kazakh, Uighur, and Uzbek. In this course we concentrate especially on Yakut (Sakha) and Azerbaijani. Modern Turkish will provide a reference language. We look at various linguistic systems within each language (phonology, morphology, syntax, and writing systems) both to understand each particular language and to see how the languages are related. We consider the impact of diachronic factors on the synchronic study of language. This course can be seen as an extended case-study for applying concepts and analytical strategies from basic linguistics, as taught in Nature of Language, Phonetics and Phonology, Invented Languages, and other relevant courses.

Prerequisite: 80-180
80-385 Linguistics of Germanic Languages  
Intermittent: 9 units  
The Germanic languages include English, Dutch, Frisian, German, 
Pennsylvania, Afrikaans, Yiddish, Icelandic and the Scandinavian 
languages, excluding Finnish. The course will serve as an extended case 
study for the application of concepts and analytical strategies taught in 
basic linguistics courses to some of these languages. Specifically, we take a 
bottom-up approach to Dutch, Frisian, Icelandic, and Danish, starting 
with raw language material whenever possible, which we progressively 
analyze in terms of phonetics and phonology, morphology, and syntax. 
These case studies lead to comparisons between the languages and insight 
to their development and divergence over time. We follow this hands-on 
approach with historical and grammatical overviews, touching on some of 
the outstanding issues in Germanic linguistics. The approach should also 
help bring out the relevance of diachronic factors in the synchronic study 
of language, with historical forms of English being open to investigation, as 
these often reflect patterns found in contemporary Germanic languages. 
Prerequisite: 80-180

80-388 Linguistic Typology: Diversity and Universals  
Fall: 9 units  
What is the most common word order? What is the rarest consonant? 
What kinds of case marking are attested in the world's languages? Which 
linguistic structures tend to co-occur? What can we learn by looking at the 
rarity of linguistic structures? These are the kinds of questions central to 
linguistic typology, the study and classification of languages based on their 
structural properties. In this course we will look at the variety of linguistic 
structures attested in several linguistic subfields, including phonology, 
morphology, syntax, and semantics. Understanding linguistic diversity is 
closely tied with the search for linguistic universals, since there appear to 
be some ways in which linguistic structures seem to be limited. But what is 
the nature of those limits (if they truly exist), and what do they tell us? We 
will also look at methodological issues that arise in comparing languages 
and forming meaningful generalizations. Prerequisites: 80-180, and one of 
80-280, 80-282, 80-285 or permission of the instructor. Prerequisites: 80-180 and (80-285 or 80-280 or 80-282)

80-405 Game Theory  
Spring: 9 units  
Game theory is the study of interactive decision-making: making choices in 
the context of other agents who are also making choices. Famous examples 
include the “Prisoner’s Dilemma” (pitting rational self-interest against 
the benefits of cooperation), and the “Cournot duopoly” (a basic model 
of market competition and supply-and-demand). Game theory has been 
adapted to situations as diverse as traffic flow, auctions, the search and 
competition for scarce resources, and bargaining. This course will develop 
conceptual and technical facility with the mathematical tools used to model 
and analyze such situations. We will cover games in strategic and extensive 
form and games of perfect and imperfect information; we will also study 
solution concepts such as Nash equilibrium and rationalizability. Finally, 
throughout the course we will take the opportunity to actually play several 
of the games we study to help build intuitions and foster insights into the 
formal mathematical models we develop.

80-411 Proof Theory  
Intermittent: 9 units  
An introduction to the general study of deductive systems and their 
properties. Topics include the natural deduction and sequent calculus; cut- 
elimination and normalization theorems; metamathematical properties 
of first-order logic and theories of arithmetic; and conservation theorems. 
Prerequisites: 80-310 or 80-311 or 21-300

80-413 Category Theory  
Fall: 9 units  
Category theory is a formal framework devoted to studying the structural 
relationships between mathematical objects. Developed in the mid-20th 
century to attack geometrical problems, subsequent progress has revealed 
deep connections to algebra and logic, as well as to mathematical physics 
and computer science. The course emphasizes two perspectives. On one 
hand, we develop the basic theory of categories, regarded as mathematical 
structures in their own right. At the same time, we will consider the 
application of these results to concrete examples from logic and algebra. 
Some familiarity with abstract algebra or logic required.  
Course Website: https://www.andrew.cmu.edu/user/jonasf/80-413-713/

80-419 Interactive Theorem Proving  
Intermittent: 9 units  
Interactive theorem proving involves using computational proof assistants 
to verify that mathematical proofs are correct, or to verify that hardware 
and software designs meet their formal specifications. This course uses a 
new interactive theorem prover, Lean, to explore this new technology and 
its logical foundations. We will study dependent type theory, a powerful and 
expressive language for representing mathematical objects, algorithms, 
and proofs. We will also consider automated methods that can be used 
in support of formal verification, including propositional, equational, first- 
order, and higher-order methods, as well as decision procedures for real and 
integer arithmetic. 
Prerequisites: 21-300 or 15-317 or 80-310 or 80-211  
Course Website: https://leanprover.github.io/theorem_proving_in_lean/

80-445 Shift Capstone Experience  
Spring  
The Societal and Human Impacts of Future Technologies capstone 
experience will be taken in either the fall or spring of the senior year. It 
is required for all SHIFT minors. The purpose of the capstone experience 
is for students to demonstrate learning over time within the minor. 
Key learning experiences include incorporating concepts, ideas, and 
frameworks from multiple disciplinary perspectives, using disciplinary 
perspectives in appropriate ways, given their complementary strengths and 
weaknesses, generating a multidisciplinary (2) of some current or near-future technology, collaborating with people of different disciplinary 
backgrounds, and communicating a single, integrated analysis of the 
impacts and opportunities of this novel technology ( and recommended 
actions). SHIFT minors should work with the minor advisor during the Spring 
of their junior year to design an appropriate capstone experience.

80-447 Global Justice  
Spring: 9 units  
Until recently, the dominant view of international relations has been that 
the governments and citizens of one country have no moral obligations to 
those beyond their borders. With the rapid growth in globalization has 
come a drastic shift in attitudes about our obligations to those with whom 
we do not share global institutions of trade but neither legal systems nor national identities. This course aims to introduce students to the problem of global 
distributive justice in the context of a globalized world, with emphases on both 
thetical accounts of justice and the practical implications of those 
accounts for important current issues. Theoretical topics will include the 
nature of justice, the sources and limits of our moral obligations, and how 
and whether those notions of justice extend to global society; while applied 
topics will include our obligations with regard to the environment, human 
rights deficits, the status of women, and global economic policy.

80-449 EHPP Project Course  
Fall: 12 units  
The Ethics, History and Public Policy Project Course is required for the 
Ethics, History and Public Policy major and is taken in the fall semester 
of the senior year. In this capstone course, Ethics, History and Public Policy 
majors carry out a collaborative research project that examines a compelling current problem that can be informed with historical 
research and philosophical and policy analysis for a chosen client. The 
students develop an original research report based on both archival and 
contemporary policy analysis and they present their results to their client 
and a review panel.

80-484 Language and Thought  
Spring: 9 units  
The goal of this course is to provide students with the opportunity to 
creatively explore some difficult questions about the relationship between 
language and thought, questions such as: How does the human capacity 
to use language relate to the human capacity to think? Does the language 
that a person speaks affect the way she thinks? If meaning is in the head, 
how can we succeed in communicating with each other? How is our ability 
to reason related to our ability to successfully communicate? None of these 
questions have definite answers; throughout the course, we will draw on 
work in philosophy, psychology and linguistics to try to understand some 
of the possible answers that might be entertained. Students in the course 
should be prepared for extensive reading, writing and peer discussion 
assignments.
80-488 Acoustics of Human Speech: Theory, Data, and Analysis
Spring: 9 units
In this course, students will learn how to acoustically analyse human speech, and in so doing, will learn about both universal and language-particular acoustic characteristics of human speech. The class, which will comprise both lectures and a lab component, will introduce the basic principles of the physics of sound and how the source spectrum is modified by the vocal tract, but the focus throughout will be towards developing a solid understanding of how to perform the relevant analyses. Each week will introduce a new topic, chosen to exemplify a particular acoustic phenomenon. Lectures for that week will provide the theoretical basis for understanding the phenomenon, both in terms of acoustic theory and in articulatory terms. The lab for that week will provide students with relevant acoustic data to analyse using PRAAT, an open-source software used for acoustic analysis. Potential topics include: What does it mean to say someone speaks with "vocal fry", and how do we measure this? Why do children replace [r] with [w]? How can we compare sounds in two different languages? For example, what are the acoustic characteristics of [r] and [l] in English and Japanese, such that these sounds count as two different sounds in English, but are so similar in Japanese? What makes an [s] so noisy compared to an [f]? What happens to speech sounds when we talk quickly, or when we're sick and our nose is stuffed up? At the conclusion of the course, students will have a solid understanding of the acoustic characteristics of human speech, both in terms of the underlying theory and how to measure such phenomena. Further, they will be able to translate questions about speech into measurable acoustic variables. There is no prerequisite for this course. While technical material will be covered, no background in linguistics, acoustics, physics, or math is assumed, and all required skills will be taught as needed.

80-495 Independent Study
Fall and Spring
Independent Study

80-500 Undergraduate Internship
All Semesters
Undergraduate Internship for Philosophy Department majors.
Course Website: https://www.cmu.edu/dietrich/students/undergraduate/resources/internship-insider/

80-514 Categorical Logic
Spring: 9 units
This course focuses on applications of category theory in logic and computer science. A leading idea is functorial semantics, according to which a model of a logical theory is a set-valued functor on a category determined by the theory. This gives rise to a syntax-invariant notion of a theory and introduces many algebraic methods into logic, leading naturally to the universal and other general models that distinguish functorial from classical semantics. Such categorical models occur, for example, in denotational semantics, e.g. treating the lambda-calculus via the theory of cartesian closed categories. Higher-order logic is treated categorically by the theory of topos. We shall see how this idea connects logic with topology (the models of a theory form a space). A prerequisite for this course is familiarity with basic category theory (as treated in the course 80-413/713).
Prerequisites: 80-713 Min. grade C or 80-413 Min. grade C
Course Website: https://www.andrew.cmu.edu/user/awodey/catlog/

80-516 Causality and Machine Learning
Fall: 9 units
In the past decades, interesting advances were made in machine learning, philosophy, and statistics for tackling long-standing causality problems, including how to discover causal knowledge from observational data, known as causal discovery, and how to infer the effect of interventions. A number of researchers have been recognized with the Turing Award (to Pearl in 2012) the Nobel Prize (to Granger in 2003 and to Sims in 2011). Furthermore, it has recently been shown that the causal view may facilitate understanding and solving various machine learning or artificial intelligence problems such as transfer learning, semi-supervised learning, disentanglement, and adversarial vulnerability. This course is concerned with understanding causality, learning causal knowledge from observational data, and using causality to tackle a class of learning problems. We will particularly focus on two key problems in causality. One is causal discovery, it is well known that "correlation does not imply causality," but we will make this statement more precise by asking what assumptions, what information in the data, and what procedures enable us to successfully recover causal information. Causal influences may take place between the underlying hidden variables, and what we measure may be their reflections; so we will also see how to find the underlying hidden "causal" variables as well as their causal relations by analyzing measured variables. Its implication in unsupervised deep learning will be discussed. The other is how to properly make use of causal information. This includes identification of causal effects, counterfactual reasoning, improving machine learning in light of causal knowledge, and forecasting in complex environments, and we will investigate how the causal perspective helps in domain adaptation, image-to-image translation, and deep reinforcement learning.

80-517 Seminar on Topics in Logic: Algorithmic Randomness
Intermittent: 9 units
What is randomness? One way to think about it is as a property of sequences of, say, events, experimental outcomes, observations, or symbols from some alphabet: a sequence is random if it is unruly, irregular, patternless. This conception of randomness plays a significant role in a variety of fields, including cryptography, information theory, the foundations of probability and statistics, computability theory, and certain computational models of learning. To build some intuition, consider the two binary strings 0010111110 and 0101010101. The first string seems more random-looking than the second. This is because the second string displays an obvious pattern that is very easy to describe and that makes it look highly predictable. But can these intuitions be made precise? Is it possible to provide a rigorous mathematical characterization of the notion of a random sequence? This seminar will provide an introduction to the theory of algorithmic randomness: an active branch of computability theory according to which a sequence is random if it does not display any algorithmically detectable patterns. We will begin by discussing von Mises’ theory of collectives, a precursor to the theory of algorithmic randomness; then, we will see how von Mises’ work led to the modern computability-theoretic approach to randomness. We will focus on both the mathematical details of the theory of algorithmic randomness and its philosophical consequences. We will pay special attention to the connections between randomness, probability, and the philosophical interpretations of probability. Among the questions that we will address are: What is the relationship between probability and randomness? Is probability more primitive a concept than randomness, or is a precise analysis of randomness needed to understand what probabilities are? Is it possible to define "absolute" randomness? Does randomness have to satisfy any laws?

80-518 Seminar on Topics in Logic
Intermittent: 9 units
Topic: Introduction to Homotopy Type Theory
Homotopy Type Theory (HoTT) is a new field of mathematics that extends Martin-Löf’s dependent type theory by the addition of the univalence axiom and higher inductive types. In HoTT we think of types as spaces, dependent types as fibrations, and of the identity types as path spaces. We will see that many spaces that are familiar to topologists can be represented as higher inductive types, and we will develop the basic theorems and constructions in HoTT to reason about them.

80-521 Seminar on Formal Epistemology: Belief and Evidence
Spring: 9 units
There has been a flurry of recent work on a variety of modal logics designed for reasoning about knowledge, belief, and evidence, in both static and dynamic contexts. What is the relationship between knowledge and belief? What is the role of evidence and justification? How do we react to new information, update our beliefs, and reason conditionally? These are old questions which modern logical frameworks promise to shed new light on. In this seminar we will read and analyze contemporary papers on these topics, both to gain an understanding of the current state-of-the-art, and to critically assess the extent to which these formal frameworks are genuinely enhancing our understanding of the underlying phenomena of interest.
80-524 Topics in Formal Epistemology: The Topology of Learning
Intermittent: 9 units
When faced with a question concerning learning or scientific method, one habitually reaches for logic and probability theory. But sometimes habits should be questioned. There is increasing awareness, scattered across philosophy, informatics, mathematical statistics, that the the relevant issues are more fundamentally topological. That may sound shocking: what could rubber geometry have to do with learning or inductive inference? The answer is that the set of empirically verifiable propositions over a set of possibilities automatically satisfies the axioms of a topological space over possible worlds. Once that is recognized, there is a systematic translation between topology and familiar concepts and issues in learning, statistics and the the philosophy of science. This seminar will introduce the relevant topological concepts and will explore the methodological correspondences in detail. Topics covered include Hume’s problem of induction, the problem of non-refutable theories and paradigm choice, convergence to the truth, simplicity and Ockham’s razor, statistical model selection, causal discovery, and computability. The class will place students at the cutting edge of research in this fresh and exciting new area, and will provide them with a high-level, explanatory perspective that unifies much of the detail encountered in standard statistics and machine learning curricula.

80-580 Seminar on the Philosophy of Language
Intermittent: 9 units
This course will provide an advanced level introduction to core topics and issues in contemporary philosophy of language and linguistic semantics. Readings will include both classic papers that provide the foundation of contemporary discussions (e.g. Frege, Kripke, Montague) and papers drawn from the contemporary literature. Possible topics include: reference and problems of reference (hyperintensionality and de se); modality; semantics of tense; introduction to formal semantic theory; compositionality; convention and linguistic meaning. This is a graduate level course. Interested undergraduates require permission of the instructor to enroll.

80-595 Senior Thesis
Fall and Spring
Philosophy Department majors writing a senior thesis, and are not participating in the Dietrich College Senior Honors Program, are given the opportunity to engage in original research under the direction of an individual faculty member. Research topics are selected by student.