

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://enr-apps.as.cmu.edu/open/SOC/SOCServlet/>) 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

Do cancel culture and "wokeness" stifle free speech on campus? When should campus speakers be protested or disinvited? Should race be considered in college admissions? Should we use genetic engineering to create super-intelligent babies? Under what circumstances, if any, is abortion permissible? When, if ever, can a doctor kill a newborn baby or a dying patient? If we can in the future, should we end human aging, allowing people to live for thousands of years? Does civilian gun ownership make people safer, and if not, should it be allowed anyway? Is the case for defunding the police compelling? Should the United States open its borders to more immigrants? Has neuroscience shown that free will is an illusion? Could a digital computer become sentient? What is the probability that we are living in a computer simulation? Is it rational to believe in God in a world that contains so much suffering? These are some of the toughest, most pressing questions of current social, moral, and 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 how to have challenging, productive, and respectful discussions across political and moral differences. You will learn to think like a philosopher - to strip an argument presented in prose to its 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.

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

The course will consider ethical questions surrounding social structure and public policy. It will analyze the role of political institutions and individual citizens in dealing with some of the greatest challenges facing our world: Global health crises, the spread of (and threats to) democracy worldwide, and world poverty. Some of the questions we will consider include: Are developed countries obligated to ameliorate poverty by providing foreign aid? What is democratic governance, and what do democratic representatives owe to their constituents? Should wealthy nations and corporations assist in the fight against life-threatening diseases worldwide? The course uses ethical and political theory, case studies, and empirical evidence to consider these questions.

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: An Introduction to Linguistics

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 learn what these tools are and practice applying them. Sub-areas of linguistics which we study 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 highlight various respects in which language and linguistics intersects 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.

80-201 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 goes 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.

80-207 Philosophy & Literature: Tolkien, Lewis, and the Inklings

Intermittent: 9 units

Does literature simply "dress up," or even distort, the claims of reason? Or can literature illuminate certain truths that philosophy does not (or cannot) express? Tackling this "ancient quarrel" between the disciplines, this course explores the work of the Inklings, a group of early 20th century Oxford thinkers committed to a strong version of the thesis that literature can articulate, even "create," unique and irreducible kinds of truth and meaning. We examine the creative and philosophical work of the four principal members of the Inklings (C.S. Lewis, J.R.R. Tolkien, Owen Barfield, and Charles Williams) and take up their debates in the work of later scholars, such as Martha Nussbaum, Nathan A. Scott, Douglas Hedley, and Judith Wolfe. The first half of this course examines the philosophical writings of the Inklings on problems of ancient and modern philosophy alongside questions of literary genre and form. In the second half, we bring these philosophical frameworks to bear in close readings of some of the Inklings' most famous works, including *The Chronicles of Narnia* and *The Lord of the Rings*.

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 amp; 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 dynamic intelligent tutoring. 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 quantificational 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 numerous philosophical issues that arise in the practice of various social sciences. One central question of the course is whether we can use traditional scientific reasoning to understand social phenomena, e.g. social inequalities, violence, changes in politics, discriminatory practices, economic forecasting, etc. in the same way that we use them to understand natural phenomena, e.g. gases, organisms, protein structure, and planetary orbits. Some of the more specific questions we address are: Because humans possess free will and act with intentions while light rays and planets in motion do not, are we forced to use different kinds of explanations in the two cases? How can we explain social institutions that depend upon cooperation when there is considerable psychological evidence that cooperation doesn't help us in achieving our own personal goals? 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 and laws of social behavior? Is our understanding of social phenomena always value laden given that values are an inherent aspect of social life?

80-226 The Nature of Scientific Revolutions

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-psychological 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 Ren and #233; 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: Making Ideas Work

Intermittent: 9 units

American Pragmatism represented 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 developed and 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 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.

80-261 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 philosophic 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

Historically and cross-culturally, philosophy tends to emerge as an effort to understand religion. Whether or not one is a believer, religion can be viewed as a "stress test" of the concepts we bring to our understanding of the mundane world. Can we know that there is an infinite being behind mundane reality? What can we comprehend about such a being? Is morality prior to or subject to that being's will? Can such a being be innocent of our wrong-doing? If there is such a being, are we responsible for anything? All of those questions depend as much on what we mean by possibility, freedom and responsibility as they do on the truth of religion. In this class, we fearlessly confront those questions and, in the Carnegie Mellon spirit, we relate each philosophical reading to relevant issues in science and logic. Since the philosophy of religion literature focuses primarily on a Judeo-Christian context, the class begins with a short survey of the religious contexts of ancient Greece, Hinduism, and Buddhism to provide points of reference from which to question Judeo-Christian presuppositions.

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.

80-285 Natural Language Syntax

Spring: 9 units

This course regards modern linguistics as a set of powerful tools for understanding and using language, and among all the subfields of linguistics, syntax as one of the most powerful. There are, however, many approaches to syntax so how should one choose which syntax to study? In 1957, Chomsky published Syntactic Structures, building on earlier research but at the same time providing a novel approach to age-old problems in linguistics, particularly the productivity problem and the learning problem. (How do speakers produce and understand novel sentences, and how do children learn without being taught?) While it is true that the field has progressed far since 1957, Syntactic Structures still stands out for its simplicity and usefulness. In this course we look at how more recent developments in syntax can be reconciled with this earlier approach. Particular focus is on how students can use syntax, in learning other languages and in refining their own use of language.

Prerequisites: 80-180 or 80-284

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

We all know that languages differ and change, and that even two people who know the "same" language can sound quite different to each other, use different words, or even different sentence structures. This course takes students on a tour through linguistic difference across languages, within languages, and over time. We will look at how historical linguists reconstruct dead languages, how sociolinguists model language change, and how linguistic typologists assess whether some linguistic features (e.g., word order) are more or less common than others. We will also explore how linguistic variation and change are related to issues of social status and political power, and we'll investigate explanations for variation and change, drawing on literature from computational modelling and psycholinguistics. There is no prerequisite, and no prior linguistic knowledge is assumed.

80-288 Intonation: The Meaning of Linguistic Tunes

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 as 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: 80-283 or 85-385 or 80-488 or 80-180 or 80-284

80-305 Game Theory

Fall: 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 applied 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 both simultaneous and sequential games and become familiar with a variety of concepts such as strict and weak dominance, randomization, expected utility maximization, never-best responses, non-credible threats, and time discounting. We'll also study solution concepts such as Nash equilibrium, correlated equilibrium, rationalizability, and subgame perfect equilibrium. 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. Some experience with mathematical methods (definitions, proofs, etc.) will be helpful.

80-306 Decision Theory

Spring: 9 units

This course is an introduction to formal models of choice and decision-making. We begin by examining choice under certainty, developing both qualitative and quantitative models of preference. We then expand our analysis to take into account uncertainty, focusing on 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

Fall: 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: 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: 21-127 or 15-251 or 80-210 or 80-211

80-311 Undecidability and Incompleteness

Spring: 9 units

U and amp; I focuses on two fundamental results: the undecidability of logic (established by Alonzo Church and Alan Turing) and the incompleteness of mathematical theories (discovered by Kurt G and #246;del). The proofs of these results require a novel metamathematical perspective, but also striking logical concepts and fascinating mathematical techniques. In this course, the theorems are not just formulated but actually proved. We begin with the axiomatic development of elementary set theory that allows, at the same time, the formal representation of informal mathematics like number theory. With this basis, one can show that syntactic notions concerning set theory are representable in the very theory. It is then easy to prove that set theory is incomplete. To show that logic is undecidable, the crucial concept of computation is introduced via Turing machines. The two central concepts - proof and computation - are fundamental for mathematics, computer science and, in particular, artificial intelligence. The undecidability and incompleteness results are among the most significant contributions of modern logic to the foundations of mathematics. They provide also the beginnings of a deeper understanding of mental processes in cognitive science and, thus, of the human mind. To understand the latter connections, we will read about and discuss historical as well as philosophical aspects of the subject.

Prerequisites: 15-251 Min. grade C or 80-211 Min. grade C or 80-210 Min. grade B or 21-300 Min. grade C or 80-310 Min. grade C

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.

80-315 Logics for Knowledge and Belief

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." "Infinitely 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 as an 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 80-211 Min. grade C or 21-127 Min. grade C or 21-128 Min. grade C or 80-212 Min. grade C or 80-210 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) probabilistic logics (and the relation between logic and probability), (4) logics of graphical causal models and counterfactuals, as well as (5) elements of probabilistic programming and computable probability theory.

Prerequisites: 80-610 or 80-310

80-324 Philosophy of Economics

Intermittent: 9 units

The science of economics has come to occupy a central position in contemporary society. Because of this central position in political decision making, economics is intertwined with a number of other philosophical issues surrounding justice, rights, and fairness. The central theme of this course will be on the arguments in favor and against markets as effective solutions to political problems. This issue will allow us to analyze a wide number of foundational issues in economics including the testability of economic claims, the use of "rationality" postulates, the foundation of the right to property, and measuring the success or failure of an economy.

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 how the causal perspective helps in solving advanced machine learning or artificial intelligence problems, including transfer learning, image-to-image translation, reinforcement learning, and unsupervised deep learning.

80-330 Ethical Theory

Spring: 9 units

This course provides a detailed survey of the structure of prominent theories of normative ethics. The space of possible consequentialist theories is surveyed in detail, allowing students to understand what distinguishes different forms of consequentialism and to assess the relative merits of these theories. The space of non-consequentialist theories is also surveyed, although in slightly less detail. The course engages classic texts from Aristotle, Kant and Mill and contemporary essays by leading philosophers.

80-334 Social and Political Philosophy

Intermittent: 9 units

Political philosophers are interested in whether, and to what extent, government use of coercion can be justified. This question involves many facets, including what gives the government the legitimate authority (if any) to coercively enforce the rules, what limits there are (if any) to the legitimate kinds of rules the government can enforce (and why), what obligations (if any) the government has to the citizens that are governed by its rules, and what claims (if any) citizens of a state can make upon one another. This course provides a systematic investigation of such questions as well as the concepts that are often appealed to in political theory, such as "justice," "equality," and "fairness." Readings will be comprised of classic and contemporary theorists from within the liberal political tradition as well as theorists critical of this tradition and its ability to live up to the lofty ideals it espouses.

80-335 Social and Political Philosophy

Fall: 9 units

Broadly speaking, political philosophers are interested in whether, and to what extent, government use of coercion can be justified, and how formal social and political institutions should be structured in order to be legitimate. Social philosophy encompasses these political questions, but also looks at how individuals should live together and how individual behaviors can impact not only state institutions but also more informal social norms and institutions. This is an advanced course in social and political philosophy, aimed at providing students with an in-depth familiarity with classic and contemporary questions both theoretical and applied.

80-336 Philosophy of Law

Intermittent: 9 units

In recent years, the U.S. legal system has been beset by claims of overcriminalization, racially discriminatory enforcement, and inadequate or unequal protection of individual civil rights. What should we make of these claims, and what, if anything, would be implied by their truth? In seeking to answer these questions, this course will examine the nature of the law and its enforcement. We will begin by discussing the issue of criminalization and whether the expansion of the criminal law is or is not problematic. From there, we will turn to the more foundational questions of what, precisely, the law is, and what its connection to morality is or should be. Are we obligated to obey the law, and if so, why? Finally, we will ask whether it is possible for the law to remain neutral with regards to morality and politics, and whether the supposed "neutrality" of the law may itself be an instrument of oppression. If the legal system lacks the kind of neutrality that many legal theorists claim for it, what (if anything) does that license us (as citizens) to do?

80-348 Health, Human Rights, and International Development

Fall: 9 units

Approximately 767 million people, or more than 10% of the world's population, live in a condition the World Bank refers to as "extreme poverty". Those who live in extreme poverty frequently lack effective access to proper nutrition, adequate shelter, safe drinking water, and sanitation. As a result, they also bear the greatest burdens of famine and epidemic disease and frequently face social and political conditions of unrest and systematic oppression. This course aims to introduce students to the problem of global public health and its intersection with claims of human rights. We will focus on theoretical accounts of human rights and questions arising from them: What constitutes a human right, and on what basis or bases might the existence of human rights be defended? If human rights exist, whose responsibility is it to see that they are defended/provided/not violated, and why? What is the relationship between health deficits and human rights deficits, and what would a "human right to health" look like? Are global institutions such as the protection of strong intellectual property rights consistent with respect for a human right to health?

80-350 Adam Smith

Intermittent: 9 units

Adam Smith is known as the father of economics. Many view Smith as a champion, not just of the science of economics, but of modern libertarian thought. His last book, *The Wealth of Nations*, is seen as the first defense of the value of free market capitalism. Less well known is Smith's earlier work which presents a altogether different picture. In it, Smith emphasizes the importance of altruism, empathy, and the value of interpersonal connection. In this course we will investigate the thought of Adam Smith, and find that he is far more complex than often portrayed.

80-358 Hume

Intermittent: 9 units

This course will investigate the philosophy of David Hume. We will focus on his philosophical thought expressed in the book *A Treatise of Human Nature*. Hume was an influential philosopher who wrote on many issues ranging from skepticism, to ethics, to the philosophy of science, and his views continue to be influential today. In this course we will attempt to understand Hume's philosophy on all of these subjects both to better understand his contribution to the philosophy of his day, but also to see what his arguments can contribute to contemporary thought.

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.

80-381 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

One of the central questions of research in human speech is how the patterning of speech sounds (phonology) relates to the articulatory, acoustics, and perceptual (phonetic) properties of speech; this problem is often referred to as the "phonetics-phonology interface". In this course, students will act as co-investigators on a topic at the phonetics-phonology interface, carrying out an acoustic study to test hypotheses that are relevant to phonological research. 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 phonetic 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, related phonological phenomena will be investigated throughout the semester. 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. Assessment will take the form of quizzes, take-home problem sets, reflections on the research process, and a final report and presentation.

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, 80-288 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, Pennsylvanisch, 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 into 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 (80-280 or 80-285 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 applied 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'll 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 calculi; cut-elimination and normalization theorems; metamathematical properties of first-order logic and theories of arithmetic; and conservation theorems. Prerequisites: 21-300 or 80-310 or 80-311

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.

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 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 theoretical 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 Capstone Course

Fall: 12 units

In this Fall 2023 capstone course, Ethics, History, and Public Policy majors will carry out a collaborative or individual research project that examines a compelling current policy issue that can be illuminated with historical research and philosophical and policy analysis. Students will develop an original research report based on both archival and contemporary data and present their results in a public forum at the end of the semester. Please note: this semester we are experimenting with a more flexible set of research options for EHPP students, rather than a single project topic that all students are required to work on. Collaborative projects in groups of 2-3 students are encouraged, but individual projects that integrate historical, ethical, and policy perspectives are permissible too.

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

All Semesters

Undergraduate Independent Study Philosophy Department majors.

80-501 Undergraduate Research in Philosophy

Fall and Spring

This course is for students pursuing a research project under the supervision of a faculty member in the Philosophy Department. Time commitments as well as specific requirements, expectations, and deliverables of the research experience must be worked out in advance between the student and the supervising faculty member. The units can vary depending on the scope of the project.

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 topoi. 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).

Prerequisite: 80-413 Min. grade C

Course Website: <https://awodey.github.io/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 causality 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?

80-521 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: Topological Philosophy of Science

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 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 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.

80-551 Seminar on History of Philosophy: Smith and Hume

Fall; 9 units

David Hume and Adam Smith are the two most famous and influential figures of a philosophical era called the Scottish enlightenment. They had significant influences on one another and on the development of philosophy and the social sciences. In this class we will read work by both of them on topics related to ethics and the social sciences, and trace some of those ideas to modern philosophical and scientific ideas.

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.