Department of Engineering and Public Policy

Note on Course Numbers

Each Carnegie Mellon number begins with a two-digit prefix which designates the department offering the course (76-xxx courses are offered by the Department of English, etc.). 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. xx-6xx courses may be either undergraduate senior-level or graduate-level, depending on the department. xx-7xx courses and higher are graduate-level and are offered by the School of Computer Science (https://enr-apps.as.cmu.edu/open/SOC/SOCServlet) each semester for course offerings and for any necessary pre-requisites or co-requisites.

19-101 Introduction to Engineering and Public Policy
Spring: 12 units
This course examines the processes of public and private decision making and of policy formation, which shape the evolution of a technology and its impact on our society. Technology plays an important role in shaping our worlds. At the same time, social forces often play a central role in the evolution of a technology. A particular technology such as an automobile or computer is chosen to study technology and policy in context. Specific topics covered in the case of the automobile includes automotive design and manufacture, safety, pollution, fuel economy and their interactions. In each area, we discuss the technological and institutional issues, their interaction, the possible need for public policy and the factors that govern the policy. The course will involve several group problem-solving sessions. Corequisites: 21-120 and 21-121 and 33-106.

19-102 EPP Sophomore Seminar
Fall: 3 units
The Sophomore Seminar has the objective of introducing the student to the interdisciplinary nature of Engineering and Public Policy problems. This is achieved through the use of case studies dealing with aspects of decision-making and ethics in policy issues which have a technological basis. Students are introduced to the technical and policy dimensions of these problems as well as to skills such as data collection and analysis, group work, and oral and written presentations. A few seminars by EPP graduates and faculty are occasionally included to give the student an idea of careers and EPP problems.

19-201 EPP Sophomore Seminar
All Semesters: 3 units
The Sophomore Seminar has the objective of introducing the student to the interdisciplinary nature of Engineering and Public Policy problems. This is achieved through the use of case studies dealing with aspects of decision-making and ethics in policy issues which have a technological basis. Students are introduced to the technical and policy dimensions of these problems as well as to skills such as data collection and analysis, group work, and oral and written presentations. A few seminars by EPP graduates and faculty are occasionally included to give the student an idea of careers and EPP problems.

19-301 Decision Making Methods for EPP
Fall: 9 units
to be determined by the department.

19-350 SP TP: Research Methods & Statistics for Engineering & Public Policy Analysis
9 units
This course synthesizes concepts from economics, statistics, decision analysis, and other humanities and social science areas as they relate to analysis of technology and public policy issues. Students will focus on applying skills, tools, and techniques of social science to critically examine issues of current importance to society that have engineering systems at their core, and how public policy can be informed by the results of these analyses. Students will discover the relationship between formulating research questions considering a wide range of perspectives (e.g., political, ethical, social, economic, and legal aspects) and implementing the appropriate methods for answering them. The course will especially emphasize interpretation and communication of analysis results in written and oral presentation, especially to non-technical audiences. As a precursor to the EPP Project courses, the course also prepares EPP juniors for structuring real-world problems into a feasible work plan, and to deal with revising work plans as work proceeds.

19-351 Applied Methods for Technology-Policy Analysis
Fall: 9 units
to be determined by the department.

19-402 Telecommunications, Technology Policy & Management
Intermittent: 12 units
This course provides a comprehensive introduction to basic principles of telecommunications technology and the legal, economic, and regulatory environment of the telecommunications industry. Topics covered are: role of new technologies such as fiber, wireless, voice over packet, and broadband access; principles behind telecommunications regulation from common carrier law and natural monopoly to open access and interconnection; differences in the treatment of telecommunications versus information services. Also, mergers, antitrust, and the changing industrial structure of telecommunications; spectrum allocation and management; and international comparison of telecommunications regulations. Special emphasis on how the new technologies have altered and are altered by regulation. Prerequisite: 73-100.

19-403 Policies of Wireless Systems and the Internet
Intermittent: 12 units
This course will address public policy issues related to wireless systems, and to the Internet. It begins by investigating policies related to a wide variety of emerging wireless systems and technologies, including WiFi, computer networks, broadband to the home, broadcast radio and television, and satellite communications. This can include the government role in facilitating the creation of infrastructure, in advancing competition among broadcasters and communications service providers, in managing spectrum, and in protecting privacy and security. The course will then address Internet policy issues, which can include Internet governance and the domain name system, taxation, privacy and security, and intellectual property. Because these are inherently interdisciplinary issues, the course will include detailed discussions of technology, economics, and law, with no prerequisites in any of these areas.

19-411 Global Competitiveness: Firms, Nations and Technological Change
Fall: 9 units
Global Competitiveness introduces students to the fundamental principles surrounding global competitiveness and technological change in the 21st century. The course is broken into three sections. The first section introduces students to competing economic, sociological, and political science theories on the structures supporting technological change. The second section presents the contemporary literature on technological change. The concluding section leverages lessons from the preceding two sections to evaluate national innovation systems, and the factors that lead to national comparative advantage. Students should leave the class able to reflect competently on what the existing literature tells us about the factors influencing global technology competitiveness, and on how modern changes in the structures supporting innovation as well as technology itself may be changing the rules of the game for firms and for nations. The course is open to undergraduate juniors, seniors & graduate students.

19-424 Energy and the Environment
Intermittent: 9 units
This course will explore the relationships between environmental impacts and the utilization of energy through a series of case studies on topics of current interest. Such topics might include the use of renewable and non-renewable fuels for electric power generation; energy use for automobiles and other transportation systems; energy use for buildings and industrial processes; and environmental issues such as urban air pollution, ozone formation, acid rain, and global warming. The emphasis will be on analysis of energy-environmental interactions and tradeoffs, and their dependency upon engineering design choices, economic variables, and public policy parameters. Junior or Senior standing in CIT or permission of instructor.

19-426 Environmental Decision Making
Intermittent: 9 units
This course will cover a number of topics in environmental decision making, including risk perception, risk communication, risk ranking, multi-attribute utility theory, decision analysis, the “precautionary principle,” the economics of environmental externalities, commons dilemmas, cost-benefit analysis, the valuation of health and environmental amenities, discounting, intergenerational equity, environmental justice, and sustainability.
19-430 Civilian and Military Applications of Space
Intermittent: 12 units
An analysis of some specific defense and space policy issues is conducted. This analysis is abstracted from a study of the specific technologies involved. An assessment of the impact of technological advancement on the military capability, space policy and arms control issues is proposed. As the exploitation of high technology has a lot of ramifications, the course focuses on some areas carefully chosen, based on the recent events, to illustrate the extent of the impact and to permit as wide-ranging a discussion as possible. Those issues cover areas of advanced imaging and target recognition capabilities; the military exploitation of new physical principles; the development of new capabilities in space for military or civilian exploitation, and the convolution of these new capabilities with the increasing technological demands of arms control. In all examples, the interaction between techno-logical progress and needs for policy changes (or emergence of policy dilemmas) are emphasized.

19-440 Combustion and Air Pollution Control
Intermittent: 9 units
Formation and control of gaseous and particulate air pollutants in combustion systems. Basic principles of combustion, including thermochemical equilibrium, flame temperature, chemical kinetics, hydrocarbon chemistry, and flame structure. Formation of gaseous and particulate pollutants in combustion systems. Combustion modifications and postcombustion technologies for pollutant control. Relationship between technology and regional, national, and global air pollution control strategies. The internal combustion engine and coal-fired utility boiler are used as examples.

19-443 Special Topics in EPP
Spring: 9 units
The idea of this course is to gain a good basic understanding of the ways in which climate change manifests in the world around us and affects human and natural systems. For each climate change impact considered we will explore possibilities of adaptation, drawing upon principles of robust decision making. We begin by reviewing the physics of the greenhouse gas effect. Next we survey large-scale natural climate variations such as ENSO and how these affect human societies. Based on this, we will look in some detail at the process of climate change detection, attribution and projection. In the second part of the course we explore how climate change is affecting specific features of the climate system and weather extremes. Here we consider temperature extremes, changes in precipitation, floods and droughts, hurricanes and the associated damages, and changes in the cryosphere (the earth’s ice and snow covered surfaces). We will discuss vulnerabilities of human and natural systems in the face of these changes and explore adaptation strategies for each impact.

19-448 Science, Technology & Ethics
Intermittent: 9 units
Technology has always been a persuasive force in society. But the last century, and especially the last 50 years have seen an unprecedented acceleration of the growth and permeation of technology. The central role of technology and engineering in the modern world calls for a reflective examination of the responsibility of those who develop, deploy and spread technologies as well as those who avail of them for various purposes. This course will explore one technology of recent origin in detail –biotechnology. After examining the way people think about and deal with technological risk, the basic science behind the technology and the ethos of science and technology, the students will learn about the philosophical foundations of possible ethics for science and technology. Projects and discussions will explore how these foundations can be used to provide ways to frame important questions and develop an understanding of an ethic for the development and use of biotechnology.

19-451 EPP Projects
Spring: 12 units
Interdisciplinary problem-solving projects in which students work as leaders or members of project teams. Problem areas are abstracted from local, state and national situations and involve the interaction of technology and public policy, with different projects being chosen each semester. Oral and written presentations concerning the results of project studies are required.

19-452 EPP Projects
Fall: 12 units
Interdisciplinary problem-solving projects in which students work as leaders or members of project teams. Problem areas are abstracted from local, state and national situations and involve the interaction of technology and public policy, with different projects being chosen each semester. Oral and written presentations concerning the results of project studies are required.

19-461 Special Topics: Invention & Innovation Materials Intensive Technologies Part 1
Fall: 4.5 units
to be determined by department.

19-500 Directed Study in EPP: Undergraduate
All Semesters
Students may do undergraduate research as one course for EPP technical elective credit, with an EPP faculty member, or on an approved project with a faculty member from another department. The research credits must be pre-approved by your advisor, and should result in a written product, one copy of which should be sent to EPP.

19-601 Information Warfare
Intermittent: 12 units
Information security is one major concern raised by the increasing use of computers in networks. In this course we first review, in some technical detail, the nature of the “threats”. These include viruses and worms (their history and how they “evolved”), backdoor exploits, Trojan horses, buffer overflows, and the extent to which they imperil the information in computers. Then we discuss the use and limitations of firewalls in protecting computer networks. We also discuss intrusion detection and the problems associated with it. We review past and present cyberattacks, like Denial of Service attacks, viruses such as Melissa and I love you, and assess their implications. We analyze the origin of computer vulnerabilities which make those attacks possible and discuss the extent to which they could be reduced. Finally, we analyze the response to this situation at the national, security and international level.

19-606 Special Topics: Civil Systems Investment Planning and Pricing
Intermittent: 12 units
Economic framework for identifying and analyzing investment and operation options facing agencies and firms, (both in theory and in practice); economic efficiency, utilization, pricing, and investment; and multi-objective evaluation.

19-609 Public Policy and Regulation
Intermittent: 9 units
Regulations are a significant policy tool of government. How society and the economy will react to new regulations can be hard to predict. Unintended side effects sometimes occur resulting in costs exceeding estimates and/or benefits never being realized. This course will review the basics of regulatory policy and using historical examples, will explore the reasons why past regulations have succeeded and failed. The second half of the course will involve 2-3 detailed case studies. Quantitative methods will be used to evaluate several pending regulations for real-world clients from both government and industry perspectives. Prerequisites: Basic statistics, economics, and quantitative methods.

19-611 Special Topics:Global Competitiveness: Firms, Nations and Technological Change
Intermittent: 12 units
This course introduces students to the fundamental principles surrounding global competitiveness and technological change in the 21st century. The past twenty years have seen dramatic changes in innovation ecosystems in the U.S. and internationally. Alone within the U.S., there has been a sharp decline in corporate R&D labs, matched by the global fragmentation of firm activities. At the same time growing linkages have been observed across institutional – firms, government labs, and universities – and national borders. These changes raise critical questions about the new rules of the game driving technological change in the 21st century. This course sheds insights into these questions through the lenses of competing economic, sociological, and political science theories on the structures supporting technological change. The course is broken into three sections. The first section introduces students to theories of the firm, bureaucracy, institutional economics, and social networks as competing frameworks within which to understand technological change. The second section presents the contemporary literature on the technological change, including creative destruction, dominate designs, industry life cycles, and networks of innovators. The concluding section leverages lessons from the preceding two sections to evaluate national innovation systems, and the factors that lead to national comparative advantage. Students should leave the class able to reflect competently on what the existing literature tells us about the factors influencing global technology competitiveness, and on how modern changes in the structures supporting innovation as well as technology itself may be changing the rules of the game for firms and for nations. The course is open to seniors and graduate students; also to juniors with instructor permission.
19-613 Industries and Technological Innovation: Positions, Paths and Progress  
Intermittent: 9 units  
This course provides an introduction to the exciting area of technological innovation. It will reflect an applied, industry oriented approach, and will emphasize empirical studies. The essence of the course revolves around a comparative analysis of how different industries develop, manage and disseminate new technologies. These will include software and the internet, automotive, semiconductors, biotech, chemicals, steel, among others. A wide range of issues will be covered, including what is product and process innovation, the role of intellectual property, coping with radical vs. incremental change, the management of knowledge, etc. The course will discuss specific industries and particular technologies, but no particular background in each technology is required for participation.

19-614 Environmental Life Cycle Assessment and Green Design  
Spring: 6 units  
Cradle-to-grave analysis of new products, processes and policies is important to avoid undue environmental harm and achieve extended product responsibility. This mini-course provides an overview of approaches and methods for life cycle assessment and green design of typical products and processes. Process-based analysis models, input-output and hybrid approaches are presented for life cycle assessment. Example software programs are used in assignments. A life cycle assessment project is required. Prerequisite: senior standing in engineering or permission of the instructor.

19-616 Case Studies in Sustainability Engineering  
Spring: 6 units  
The principles and tools of sustainability have yet to be applied on a large scale to solving real-world engineering problems. In this course, we explore the use of these principles and tools to various case studies. Prerequisites: 12-714 or 19-614 or 19-622 or 12-712.

19-622 Introduction to Sustainable Engineering  
Fall: 6 units  
Society has generally assumed that the earth’s resources are limitless and wastes can be disposed of without serious consequences, but the validity of these assumptions is now being challenged. This course begins with an overview of the concept of sustainability and its history, including changing attitudes and values toward technology and the environment through the twentieth century. Key conferences and reports that helped define sustainability are reviewed. Models for population growth, global food production, and global water resources are then presented, and current problems of land use, urbanization, and energy and material resources are discussed. Overall, the course material provides a context for engineering decisions in the twenty-first century, which are quite different from decisions of engineers in the past. Prerequisite: senior standing in engineering or permission of the instructor.

Course Website: http://www.ce.cmu.edu/~cliff/sustainability.htm

19-623 Industrial Ecology and Sustainable Engineering Design  
Fall: 6 units  
This course uses the context established in 12-712 / 19-622 to explore the solution space of engineers in tackling basic problems facing human civilization. The course begins with the concept of a system, using the earth’s life support systems as examples. The potential damage of conventional engineering decisions on these life support systems is discussed. Models of industry based on life sciences are then explored, and tools for sustainable engineering are presented. These tools include metrics of sustainability, principles of design for the environment, methods for pollution prevention, and use of mass and energy balances in the design of sustainable systems. Finally, the principles and tools of sustainable engineering are used to explore solutions to some of the most challenging problems identified in 12-712 / 19-622. Prerequisites: 19-622 or 12-712.

19-644 Medical Devices  
Intermittent: 9 units  
This course is an introduction to the engineering, clinical, legal and regulatory aspects of medical device performance and failure. Topics covered include phenomenological and mechanistic descriptions of processes such as wear, corrosion fatigue and fretting, in addition to the characterization of bone and other biological materials as it relates to device performance requirements, including biocompatibility. The course also involves case studies of orthopedic fixation devices and prostheses, pacemakers, heart valves and artificial organs. A major portion of the course is a final design project which involves the design of a new medical device or the redesign of an existing device.

19-650 Climate and Energy: Science, Economics and Public Policy  
Intermittent: 9 units  
The climate problem ties energy policy to the geosciences in one of the central environmental dilemmas of the new century. How much will the planet warm? Can we avert climate change without wrecking our economy? The political and economic stakes are high. We will first explore the science of climate change through study of simple physical models of the atmosphere and climate. Topics will include models of atmospheric radiation and of the vertical and latitudinal temperature structure of the atmosphere. In the latter half of the course we will focus on energy policy through study of the engineering and energetic constraints on industrial systems. Topics will include primary energy sources, energy conversion technologies, and energy economics and policy. Throughout the course we will alternate between lectures that survey of the key topics and detailed examples that require student involvement. Analysis of the energy flows and transformations will serve as a unifying theme for the course.

19-662 Special Topics: Technology and Development in China & India  
Intermittent: 12 units  
This course will explore the role of technology and economic development in India and China. It will open with three lectures that provide a theoretical framing for the course drawing broadly on the literature in economics and technical innovation. The balance of the semester will consist of a set of classes on the role of technology and innovation in India followed by a parallel set on China. The course will conclude with some cross-comparison between the experience and prospects in both nations. The course is open to undergraduates and graduate students. Students will be expected during each class to demonstrate mastery of individual concepts through in-class participation and occasional in-class quizzes on the assigned readings. Students will in addition choose a topic of interest to which to apply concepts in the form of three paper assignments across the duration of the course. These three paper assignments will include two mid-term assignments, one on India and one on China, and a final term paper building on the previous two papers to compare lessons across the two countries.

19-680 E&TIM Seminar on Innovation Management in Practice  
Intermittent: 6 units  
Innovation has been described as “the intersection of invention and insight, leading to the creation of social and economic value.” Companies increasingly rely on innovation to establish and drive their success. Public policy makers see innovation as a critical driver for economic development. This course is an opportunity to learn about innovation management from those in the front line. How are innovation opportunities identified? What are the challenges to realizing these opportunities, and how can the challenges be addressed? What roles are played by processes, technologies and the business environment, as well as by individuals in organizations? This course will feature speakers who drive innovation in a variety of settings, paired with readings from the innovation literature that will help frame the presentations and discussion.

19-681 Managerial and Engineering Economics  
Intermittent: 12 units  
The course emphasizes the application of economic principles (e.g., marginal analysis, supply and demand, competitive equilibrium, imperfect competition and monopoly) and fundamental engineering economics (e.g., quantifying costs and benefits, net present value, decision making under uncertainty) to managerial decision making. Topics include production and costs, elements of decision analysis, market mechanisms, pricing decisions, and information economics. The coverage of these topics fosters an understanding of the organization of firms and markets and firm decision making in the context of exploring, evaluating, and managing opportunities for technological innovation and diffusion.

19-682 The Strategy and Management of Technological Innovation  
Intermittent: 12 units  
The course on Strategy and Management of Technological Innovation prepares professionals with technical and scientific backgrounds for managing technology within an organization and the broader strategic decision-making required at the corporate level. This course teaches how an appropriate incorporation of technology and innovation into corporate strategy and management can lead the firm to achieve profitable and sustainable competitive advantage. It addresses the role of technology management in both emerging and established firms, and examines how all of the firm’s activities, assets, and relationships must complement one another in order to capture value from innovation. The course will cover the frameworks, models and tools essential for those actively engaged in the innovation process within a firm and apply these to case studies illustrating their importance in technology industries.
19-687 Principles and Practices of R&D Management
Intermittent: 6 units
This course considers key issues and trade-off in R&D strategy and organization, paying attention to dynamic competitive contexts where technology plays a key role. These topics are treated assuming the perspective of the decision maker. It addresses typical problems of large, medium and small firms having a structured R&D and operating businesses where R&D is the source of competitive advantages. Although we will heavily focus on R&D, emphasis is placed on viewing R&D as a part (although, a key part) of the process of technological innovation; therefore, as an activity to be strongly and appropriately integrated with other functions to make innovation successful.

19-688 Innovation for Energy and the Environment
Intermittent: 12 units
Issues in energy and the environment may be framed in different ways. Engineers may describe a technical system while social scientists may choose policy terms. To these views, this course adds the business and innovation dimensions, which provide additional motivation for change in these dynamic areas. The class will explore opportunities for economic, environmental and social value creation for several cases, each of which has its own set of considerations for resources, stakeholder perspectives, business challenges and technical opportunities. The course will emphasize utilization of methods, tools and frameworks to describe and evaluate potential innovation opportunities in the energy and environmental sectors. Upon completion of the course, students should be able to evaluate the economic and environmental aspects of business decisions in these sectors, and know how to assess possible adoption paths, impacts and benefits.

19-693 Managing and Leading Research and Development
Intermittent: 12 units
Please refer to the description for ECE course 18703 at http://www.ece.cmu.edu/courses/18703. The EPP number is a cross listing of this same course.

19-699 Special Topics: Institutions Entrepreneurship and Innovation
Intermittent
Institutional environment and public policy greatly affect incentives determining the direction of entrepreneurial activity and innovation that are the engines of economic growth. In societies with poor institutions, entrepreneurial talent is mostly directed towards seeking rents rather than generating productive innovations. But even in modern capitalist economies entrepreneurial activity and innovation are strongly influenced by public policies, for example, those related to intellectual property rights. This course seeks to provide students with analytical frameworks that will enable them to understand how various formal and informal institutional arrangements and public policy decisions influence entrepreneurial activity and innovation and how this, in its turn, affects economic efficiency and growth potential of nations.

19-701 Introduction to the Theory and Practice of Policy Analysis
Intermittent: 12 units
This course reviews and critically examines a set of problems, assumptions and analytical techniques that are common to research and policy analysis in technology and public policy. Topics covered include the difference between science, trans-science and policy analysis, policy problems formulated in terms of utility maximization, issues in the valuation of intangibles, uncertainty in policy analysis, selected topics in risk analysis, limitations and alternatives to the paradigm of utility maximization, issues in behavioral decision theory, issues related to organizations and multiple agents, and selected topics in policy advice and policy analysis for the federal government. The objective is to look critically at the strengths, limitations and underlying assumptions of key policy research and analysis tools and problem framing and sensitize students to some of the critical issues of taste, professional responsibility, ethics, and values that are associated with policy analysis and research.

19-702 Quantitative Methods for Policy Analysis
Intermittent: 12 units
Economic framework for identifying and analyzing investment and operation options facing agencies and firms, (both in theory and in practice); economic efficiency, utilization, pricing, and investment; and multi-objective evaluation.

19-703 Survey, Design and Analysis
Intermittent: 6 units

19-704 Applied Data Analysis
Intermittent: 6 units
Applied Data Analysis is a course that will cover several statistical procedures, including multiple regression with interactions, logistic regression, signal detection analysis, principal components analysis, factor analysis, and possibly other techniques, with an emphasis on hands-on data analysis.

19-705 Workshop Applied Policy Analysis
Intermittent: 6 units
The course is designed to provide experience in setting up, analyzing, and writing about policy problems of the type that are used in the EPP Part B qualifying exam. Over the course of the semester, the class works through six or seven policy case problems. Much of the work is done in small groups. The principal focus is on integrating the qualitative and quantitative aspects of the problems and on identifying and practicing general problem-solving strategies.

19-712 TBA
Intermittent: 12 units
**Note: This is the old course title. The new title for this course is Industrial Ecology and Sustainable Engineering. This course begins with an overview of the concept of sustainability, including changing attitudes and values toward technology and the environment through the twentieth century. Models for population growth, global food production, and global water resources are then presented, and current problems such as land use, urbanization, and energy and material resources are discussed. Models of industry based on life sciences are then explored, and tools for sustainable engineering are presented. These tools include metrics of sustainability, principles of design for the environment, methods for pollution prevention, and use of mass and energy balances in the design of sustainable systems. Prerequisite: senior/graduate standing in engineering or permission of the instructor.**

19-714 Environmental Life Cycle Assessment
12 units
Cradle-to-grave analysis of new products, processes and policies is important to avoid undue environmental harm and achieve extended product responsibility. This course provides an overview of approaches and methods for life cycle assessment and for green design of typical products and processes using the ISO 14040 family of standards. This includes goal and scoping definition, inventory analysis, life cycle impact assessment (LCIA), interpretation, and guidance for decision support. Process-based analysis models, input-output and hybrid approaches are presented for life cycle assessment. Example software such as MATLAB, Excel, and Simapro are introduced and used in assignments. A group life cycle assessment project consistent with the principles and tools of sustainability to solve real-world engineering problems is required. Prerequisites: 12-411 or 12-706.

19-752 EPP Project Management
Fall and Spring: 12 units