Certificate	Number	Course Name	Course Description
Plastics Materials, Graduate Certificate	PLAS.5440	Advanced Plastics Materials	This course reviews the historical developments of polymeric material systems, commodity, engineering, biodegradable, and high performance thermoplastic include their synthesis, structure, properties, and applications and there is also an overview of typical additives that are used to modify the properties of plast Knowledge of general and/or organic chemistry is recommended as a prerequisite for this course.
Wind Energy Engineering, Graduate Certificate	MECH.5580	Aero/Wind Eng	This course will introduce and examine classical and modern theoretical and computational two and three dimensional aerodynamics and aeroelastic modelin applications in wind and subsonic aero/hydrodynamics applications. In addition, wind and meteorological science as well as simple FEM structural modeling a coupling concepts will be examined. The class will comprise scheduled lectures and discussions. Students will be expected to perform presentations and direct projects which involve computer programming.
Environmental Atmospheric Science, Graduate Certificate	ATMO.5230	Air Pollution Control	This course describes air pollutants, their characterization, ambient concentrations, effects on human health and the ecology, and the environmental laws and regulations that set standards on emission rates and ambient concentrations. The basics of air pollutant dispersion and transport are also covered. The main f course is on emission control technologies for particulate matter, carbon monoxide, sulfur oxides, nitrogen oxides, organic and inorganic toxic pollutants. The technologies are discussed: cyclones, scrubbers, electrostatic precipitators, baghouses, adsorption, absorption and incineration. The automobile and its emiss are reviewed. Alternative methods are also discussed, such as fuel substitution, conservation and efficiency improvement.
Environmental Atmospheric Science, Graduate Certificate	ATMO.5710	Air Pollution Phenomenology	The course centers on transport, dispersion and transformation of air pollutants in the atmosphere. Atmospheric structure and dynamics are reviewed. The at dispersion equation is developed for instantaneous and steady- state releases of pollutants, including the Gaussian Plume Equation for point, line and area sou sources and transport of particulate matter are discussed, including haze and visibility impairment. Other topics are photooxidants (ozone), acid deposition, stratospheric ozone depletion and the greenhouse effect.
Energy Conversion, Graduate Certificate	EECE.5280	Alternative Energy Sources	PV conversion, cell efficiency, cell response, systems and applications. Wind Energy conversion systems: Wind and its characteristics; aerodynamic theory of w wind turbines and generators; wind farms; siting of windmills. Other alternative energy sources: Tidal energy, wave energy, ocean thermal energy conversion, geothermal energy, solar thermal power, satellite power, biofuels. Energy storage: Batteries, fuel cells, hydro pump storage, flywheels, compressed air.
Renewable Energy Engineering, Graduate Certificate	EECE.5280	Alternative Energy Systems	PV conversion, cell efficiency, cell response, systems and applications. Wind Energy conversion systems: Wind and its characteristics; aerodynamic theory of w wind turbines and generators; wind farms; siting of windmills. Other alternative energy sources: Tidal energy, wave energy, ocean thermal energy conversion, geothermal energy, solar thermal power, satellite power, biofuels. Energy storage: Batteries, fuel cells, hydro pump storage, flywheels, compressed air.
Environmental Biotechnology, Graduate Certificate	CIVE.5780	Biological Wastewater Treatment	Course covers the theoretical and practical aspects of biological wastewater treatment operations. Topics include kinetics of biological growt substrate utilization, materials balance in chemostats and plug flow reactors, activated sludge process analysis and design, sedimentation a thickening, nitrification and denitrification, phosphorus removal, fixed-film processes analysis and design, anaerobic processes analysis and aerated lagoons and stabilization ponds, and natural treatment systems.
Environmental Biotechnology, Graduate Certificate	BIOL.5230	Biology of Global Change	
Security Studies, Graduate Certificate	CRIM.5700	Crisis and Emergency Management	This course will provide a broad introduction to the critical challenges of disaster management. The course will address past and present str for reducing and responding to hazards posed by both manmade and natural disasters. Emphasis will be placed on what we can learn from history of disasters, and on how we can apply those lessons to the management of future events.
Design & Manufacturing Engineering, Graduate Certificate	ENGN.5400	Designing Sustainable Products	The course introduces students to the sustainability aspects of product design. Sustainable products are designed to conserve materials and energy, select low-impact materials, eliminate toxic substances, extend product life, re-use materials, and reduce the generation of wastes. entire product life cycle will be considered including: material extraction, material processing, manufacturing, transportation, product use, a disposal. Students will learn the impact of design solutions in a global, economic, environmental, and societal context. The students will lea strategies to identify the sustainability impacts throughout the product life cycle, as well as the application of sustainable product design pri and strategies to address these impacts.
Integrated Engineering Systems, Graduate Certificate	EECE.5290	Electric Vehicle Technology	Electric vehicle VS internal combustion engine vehicle. Electric vehicle (EV) saves the environment. EV design, EV motors, EV batteries, EV battery chargers and algorithms, EV instrumentation and EV wiring diagram. Hybrid electric vehicles. Fuel cells. Fuel cell electric vehicles. The course includes independent work.
Environmental Atmospheric Science, Graduate Certificate	ENVI.5720	Energy and Environment	This course discusses the world and U.S. primary energy resources and consumption, including fossil, nuclear and renewable energy sources. Principles of thermodynamics are reviewed, especially in regard to energy usage efficiency improvement. A significant part of the course is devoted to electricity productio including site visits to fossil and nuclear power plants. The environmental effects are discussed of energy extraction and consumption, such as SOx, NOx and p matter emissions, acid deposition, the greenhouse effect, radioactive waste disposal. Also the risks of accidents are discussed in fossil and nuclear fuel usage.
Renewable Energy Engineering, Graduate Certificate	MECH.5285	Energy Policy and Energy Codes	Explore and codify the status of the world's energy infrastructure and discuss energy-related policies. Identify areas of energy inefficiency and examine pathw future dominated by renewable and sustainable resources.
Renewable Energy Engineering, Graduate Certificate	MECH.5040	Energy Systems Design Workshop	A group design of an innovative energy system. Integration of many aspects of the student's engineering background, including design concepts, technical ana economic and safety considerations. Ideally the whole design cycle of design, build, test. A formal report and oral presentation.
Environmental Biotechnology, Graduate Certificate	CIVE.5670	Environmental Aquatic Chemistry	This course provides environmental understanding of the principles of aquatic chemistry and equilibria as they apply to environmental syste including natural waters, wastewater and treated waters.

Environmental Biotechnology, Graduate Certificate	CIVE.5680	Environmental Fate and Transport	The fate of contaminants in the environment is controlled by transport processes within a single medium and between media. The similariti contaminant dispersion within air, surface water and groundwater will be emphasized. Interphase transport processes such as volatilization adsorption will then be considered from an equilibrium perspective followed by the kinetics of mass transfer across environmental interfaces professional presentation of a select paper or group of paper concerning a course topic is required.
Public Health Studies, Graduate Certificate	PUBH.5061	Environmental Health	This environmental health course explores the links between human activities and environmental systems and examines how these interactions can impact hu health. The course is designed to provide knowledge and skills necessary to understand how human and industrial activities such as population growth, metho production, pollution of the air and water, waste, the built environment, toxic substances, pest control, and global climate change can result in human disease impact the environment. Understanding the links between human activities and environmental systems is essential to developing effective prevention strateg building sustainable communities.
Paralegal Studies, Certificate	LGST.3670	Environmental Law	This course examines the legal and administrative problems of protecting the quality of the human environment. Federal and state legislati environmental policy is studied. Public interest litigation as a supplement to the enforcement of environmental law is discussed. The course focuses on the practical problems of balancing the needs of business, the global competitiveness of the United States, the increasing demar natural resources, and the need to protect, preserve, and restore the environment. The importance of sustainable development and enviror ethics are discussed.
Nanotechnology, Graduate Certificate	PUBH.6100	Exposure Assessment	Concepts of quantification of occupational exposures (chemical and physical hazards) for purpose of correlating health effects with exposures. Topics discusse reasons for conducting exposure assessment, sampling methods, sampling strategies (for epidemiology, compliance, control), and statistical considerations. P are illustrated through a series of case studies.
Renewable Energy Engineering, Graduate Certificate	MECH.5290	Fuel Cell Fundamentals	The primary objective of this course is to understand the fundamental science and engineering of fuel cells and redox flow batteries (i.e., reversible fuel cells). fundamental principles of electrochemistry, thermodynamics, and kinetics of electrochemical reaction processes, as well as mass transport in electrochemical systems will be considered. Emphasis will be placed on operating principles and the design and diagnostics of the proton exchange membrane fuel cell as a po energy conversion system, and the vanadium redox flow battery as a large-scale energy storage system. Cell components and their influence on the overall pe of these systems will be discussed in detail. An introduction to the cost analysis of electrochemical energy storage will be presented.
Energy Conversion, Graduate Certificate	MECH.5210	Fundamentals of Solar Energy Engineering	Utilization Terrestrial irradiation on tilted surfaces; radiation, conduction, convection in collectors; absorptance, emittance, reflection, transmittance of solar i energy flow in flat plate and concentrator collectors; storage; design tools; small project; web-based.
Renewable Energy Engineering, Graduate Certificate	MECH.5350	Fundamentals of Sustainable Energy	Introduction to scientific principles associated with sustainable energy technologies. Topics include: thermodynamic laws and engineering fundamentals in en processes, thermodynamic energy conversion, wind and geothermal energy, photovoltaics, ocean thermal energy conversion, electrochemical energy, biomas selected emerging energy technologies.
Peace & Conflict Resolution, Graduate Certificate	PCST.5250	Gender, Work and Peace	"Gender, Work and Peace" will explore the relationship between human rights, gender and nonviolence in the 21st century. We will examine how current anc reality can be shaped by related policies, specifically those on the micro and macro level concerned with gender. Today we live in a period of global transition comparable to the period that followed the Industrial Revolution. It presents us with enormous challenges and opportunities regarding factors we will addres economic globalization, government restructuring, work-family balancing, environmental safety at work, gender inequalities and the connection between hun and dignity at work.
Supply Chain & Operations Management, Graduate Certificate	POMS.6020	Global Supply Chain Management	Supply chain management has become a crucial factor in the success of many leading organizations, including for-profit and not-for-profit companies, government agencies, and humanitarian relief efforts. This course will start with principles and concepts of supply chain manag tracing the flows of materials, funds, and information required to develop and deliver products and services around the globe. Topics covere include sourcing, logistics, demand planning, and inventory management, along with the use of quality tools and lean methodologies to imp supply chain operations and develop supplier relationships. This course will also discuss the challenges, key issues, and trends in global sup chain management, such as sustainability, disruptions, security, and innovation.
Renewable Energy Engineering, Graduate Certificate	MECH.5340	Green Combustion and Bio-Fuels	Fundamentals of combustion and pollutant formations in application to internal combustion engines, turbines, and fire safety. Concepts include flame structu speed, flammability,ignition, reaction kinetics, nonequillibrium processes, diffusion flames, and boundary layer combustion. Additional specific emphasis on c modeling, green approaches to energy production, and biofuels.
Renewable Energy Engineering, Graduate Certificate	MECH.5250	Grid-Connected Solar Electric Systems	Students will study the concepts and design considerations of grid-connected, solar-powered, electrical generation systems, from residential through utility sc Emphasis will be on practical applications that help make the student "work ready" at graduation. Grading consists of two tests during semester; one individu (residential scale PV system); and one group project (commercial-scale system). This course fulfills an elective requirement for renewable energy students.
Environmental Biotechnology, Graduate Certificate	CIVE.5950	Hazardous Waste Site Remediation	This course focuses on the principles of hazardous waste site remediation (with an emphasis on organic contaminants) using physical, chem biological remediation technologies. Both established and emerging remediation technologies including: bioremediation, intrinsic remediatio vapor extraction (SVE), in situ air sparging (IAS), vacuum- enhanced recovery (VER), application of surfactants for enhanced in situ soil wa hydraulic and pneumatic fracturing, electrokinetics, in situ reactive walls, phytoremediation, and in situ oxidation, will be addressed. A term and professional presentation in class regarding a relevant topic is required.
Domestic Violence Prevention, Graduate Certificate	PUBH.6250	Health Policy	This course provides students with a basic framework for health policy analysis and examines major aspects of U.S. health policy. Detailed consideration and discussion focus on the relationship of national policy to the planning, implementation and funding of healthcare services. course covers topics such as the healthcare policy environment in the U.S, government-funded healthcare through Medicaid and Medicare, Massachusetts healthcare reform.

Nanotechnology, Graduate Certificate	PUBH.5250	Industrial Hygiene and Ergonomics	A survey course covering introductory topics in ergonomics and industrial hygiene. Ergonomics topics include work measurement, anthropometry, biomechar psychosocial stress and work reorganization, special emphasis is placed on the recognition and control of work-related musculoskeletal disorders. Industrial h topics will cover the identification, measurement, and control of chemical and physical hazards in the work environment including principles of air sampling ar ventilation and other control technologies, and the use of personal protective equipment with special attention to respiratory and hearing protection.
Paralegal Studies, Certificate	LGST.3660	International Law	This course provides a broad introduction to international law with emphasis on current issues. Within public international law, topics covere include the recognition of new states, organizations such as the United Nations and the European Union, the use of force, human rights, international crimes, the global environment, and international courts and tribunals. Within private international law, topics surveyed will in legal aspects of international trade and foreign investment, labor, intellectual property, cyber theft, and taxation. Current issues discussed include global warming, recent corruption scandals, the Eurozone crisis, and legal issues facing global technology companies.
Nanotechnology, Graduate Certificate	ENGN.5500	Introduction to Nanotechnology	This course is designed to provide you with a broad overview to the multi-disciplinary field of nanotechnology. The course is team-taught by researchers from engineering, health and environment, management, and humanities disciplines. The topics include an introduction to nanoscale phenomena; fundamental the concepts and experimental techniques in nanotechnology; nanoscale manufacturing and processing; innovative nanomaterials for various applications; applic the technology; and environmental and health impacts of nanotechnology.
Renewable Energy Engineering, Graduate Certificate	PLAS.5470	Materials for Renewable Energy and Sustainability	This course reviews the selection and design of materials for use in energy generation and conservation applications. Both traditional and renewable technolo energy generation are reviewed, and the differences in materials needs for generation, storage and transmission highlighted. Particular emphasis is placed on and polymeric materials technological challenges in solar, wind and hydro/geothermal energy and future transportation fuel production. The concept of life cy assessment is introduced for the optimization of systems from a materials science perspective. The impacts of global economics, ethics and efficiency are also addressed. The course approaches sustainability as an open-ended, complex engineering problem and introduces students to the broad range of career oppor materials engineers in renewable energy.
Renewable Energy Engineering, Graduate Certificate	MECH.5330	Nanomaterials for Energy	Introduction of fundamental materials development and principles in addressing issues associated with affordable and sustainable energy. The course starts w concepts in materials science and engineering, with special attention paid to the origin of size effects in controlling the properties of nanomaterials. Then a ra materials issues related to development of renewable energy resources and sustainable energy technologies will be discussed. Topics to be covered include: photovoltaic materials and solar energy conversion; thermoelectric materials; materials for electrical energy storage and generation; materials for hydrogen p piezoelectric energy harvesting; and materials for other emerging energy processes.
Wind Energy Engineering, Graduate Certificate	MECH.5840	Ocean Engineering	Physical Properties of the Ocean Environment, ocean wave mechanics, computer solutions of wave interactions, physical modeling of marine vehicles and coa environments (modeling and scaling laws), resistance and propulsion of surface ships and submarines, and forces on floating and submerged objects such as b pipelines, piers, and breakwaters. Research report required summarizing some aspect of ocean engineering.
Renewable Energy Engineering, Graduate Certificate	MECH.5280	Photovoltaic Manufacturing	Overview of the manufacturing processes used to make a typical crystalline solar cell. Detailed study of selected processes and manufacturing problems, such cell testing, characterization, reliability issues, factors affecting yields, automated material handling, affect of impurities in crystal growth.
Plastics Materials, Graduate Certificate	PLAS.5970	Plastics & Environment	This course investigates the waste management solutions for different types of plastics. Both traditional and emerging recycling methods will be highlighted. Accumulation of plastic waste in the natural environment and the toxicology of plastics as well as their additives will be discussed, Further, analysis methods a instrumentation to characterize recycled plastics, and the differences in virgin polymers and recycled polymers will be introduced. Potential degradable, biode or biobased alternatives will be reviewed along with the concepts of life cycle assessment and Green Chemistry for designing the most sustainable plastic mat
Plastics Engineering Materials, Seminar	Seminar	Plastics and Sustainability	This two-day seminar will cover the recycling of plastic waste and the development of bio-based plastics materials. DAY 1 Review the current relationship between plastic and the environment Overview of plastic materials and plastic production processes Accumulation of plastic waste in the natural environment and the toxicology of plastics and their additives Waste management solutions for different types of plastics. Both traditional and emerging recycling methods will be highlighted, with particular emphasis on and chemical recycling processes. In addition, analysis methods and instrumentation to characterize recycled plastics — and the differences in virgin polymers recycled polymers — will be introduced. DAY 2 Detailed overview of current definitions and standards for bio-derived, biodegradable plastics and elastomers Design criteria for sustainable plastics based on a brief overview of life cycle analysis in the context of plastics Introduction to sustainable material options available currently — plastics, elastomers and additives — that can be obtained from renewable resources. Detai descriptions will be provided for naturally occurring polymers including natural rubber, cellulose and starch as well as polymers such as polylactic acid (PLA), polyhydroxyalkanoates (PHA), and polybutylene succinate (PBS) that can be produced from naturally occurring precursors. The class material will also touch u polymers from natural oils and additives from natural resources including natural fillers, fibers and clay nanocomposites. A brief discussion of processing these bio-based materials will also be included. A brief introduction to Life Cycle Analysis (LCA) and general design criteria for sustainable plastics

Energy Conversion, Graduate Certificate	EECE.5150	Power Electronics	A one-semester course with emphasis on the engineering design and performance analysis of power electronics converters. Topics include: power electronics (power MOSFETs, power transistors, diodes, silicon controlled rectifiers SCRs, TRIACs, DIACs and Power Darlington Transistors), rectifiers, inverters, ac voltage controllers, dc choppers, cycloconverters, and power supplies. The course includes a project, which requires that the student design and build one of the pow electronics converters. A demonstrative laboratory to expose the students to all kinds of projects is part of the course.
Energy Conversion, Graduate Certificate	EECE.5250	Power Systems Distribution	An intermediate course in analysis and operation of electrical power distribution systems using applied calculus and matrix algebra. Topics include electrical lc characteristics, modeling , metering, customer billing, voltage regulation, voltage levels, and power factor correction. The design and operation of the power d system components will be introduced: distribution transformers, distribution substation, distribution networks, and distribution equipment.
Environmental Geoscience, Graduate Certificate	GEOL.5240	Regional Hydrogeology	Concentrating on the storage and steady state flow of ground water at a basin-wide scale, thecourse studies flow nets, fluid potential, and numerical modelin controlled by basingeometry and geology; water movement in the zone of aeration, the interaction of groundwaterwith surface water, the transport and disp contaminants, and the use of modeling forgroundwater management.
Renewable Energy Engineering, Graduate Certificate	MECH.5270	Solar Energy Engineering	Systems engineering, stochastic modeling, design, and life-cycle cost analysis of several solar systems: photovoltaics, passive heating, solar cooling, and daylig Based.
Environmental Atmospheric Science, Graduate Certificate	MECH.5210	Solar Fundamentals	Utilization Terrestrial irradiation on tilted surfaces; radiation, conduction, convection in collectors; absorptance, emittance, reflection, transmittance of solar i energy flow in flat plate and concentrator collectors; storage; design tools; small project; web-based.
Peace & Conflict Resolution, Graduate Certificate	PCST.5270	Sustainable Housing Development and Land Use: Conflict, Policy, and Practice	Housing is fundamental to the quality of life in communities, and housing conflict, policy and practice shape the availability of this fundamental good. This cou examine the economic, environmental, social, and cultural factors that shape housing and its sustainability. The contentious nature of housing and land use pc United States will be summarized, with students learning how housing policy impacts communities, states, and regions. The course will then give students a d understanding of the conflictive process through which housing is developed and the role the market, government, funders, workers, and housing consumers influencing the creation and development of housing. The course will highlight ways in which current housing development policy and practices are not sustai will examine more recent efforts to establish standards and practices that enhance consensus and sustainability. Students will learn how to manage conflict ai housing project through the various stages, such as project conceptualization, market analysis, design, site acquisition, financing, construction, and occupancy course focuses on the U.S. context, students will learn of international efforts to achieve greater sustainability in housing. The course will provide students wit practical and theoretical knowledge of housing and land use conflict, policy and development practices. Case studies of actual projects will be presented.
Environmental Atmospheric Science, Graduate Certificate	ATMO.5080	The Climate System	The main elements of the Climate System are the atmosphere, ocean, biosphere, land surface, and the cryosphere; the primary input of energy is from the Su course examines these elements, the ways in which they interact and how they can be modeled. The Global Energy Budget is examined and both natural and caused climate change are considered.
Environmental Geoscience, Graduate Certificate	GEOL.5150	Topics in Environmental Geochemistry	Case-based course dealing with the application of thermodynamics and kinetics, acid-base equilibria, oxidation-reduction reactions, radioactive and stable iso mineral chemistry to the understanding and solution of environmental problems. Other topics will be considered based on student interest.
Nanotechnology, Graduate Certificate	PUBH.5030	Toxicology and Health	The course introduces students to the basic principles and mechanisms of toxicology with a focus on occupational and environmental health. Concepts of dos rate, dose-response analysis, and test systems are presented in the context of the toxicology of major organ systems and toxic agents. The course covers toxic major organ systems (respiratory, dermal, immunologic, cardiovascular, neurological, reproductive systems, and cancers), major classes of contaminants (airb particles, respirable fibers, vapors/gases, heavy metals, organic solvents, pesticides, sensitizers, emerging contaminants), and their mechanisms of action. A re the necessary human biology and biochemistry of life is also provided.
Wind Energy Engineering, Graduate Certificate	MECH.5260	Transport Processes in Energy Systems	Course focuses on the development of a fundamental understanding of transport processes from a multi-scale and multi-physics perspective, and the applicat understanding to the analysis of energy engineering systems. Derivations of the equations describing the mechanisms for mass, momentum, and energy trans presented, together with approaches for the evaluation of material properties and constitutive relations. Emphasis is placed on a holistic view of transport pr combinations of transient, advective, diffusive, and reactive phenomena.
Wind Energy Engineering, Graduate Certificate	MECH.5220	Wind Energy Fundamentals	An overview of all aspects of wind energy power generation: The nature of and statistics of wind, turbine siting requirements, aerodynamics of the rotor syste mechanical power transmission, generators, blade construction, structural analysis of turbine components, electrical power distribution.