Course Description

2015. 10

Energy Systems Engineering

Course Number	ES601	Course Title	Thermodynamics of Energy Systems
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Senior & Graduate	Prerequisite	None
This course introduces modern thermodynamics aiming at understanding how to utilize it to design novel materials and systems for renewable energy sources. Students will be guided a rigorous methodology determining equilibrium states, constructing phase diagrams and novel alloy theories. Modern theories of statistical mechanics and ab-initio computational thermodynamics which describe thermodynamics systems at atomic and molecular levels, will be offered to catch the frontier science and technology up in the designing of novel energy system.			

Course Number	ES603	Course Title	Electrochemistry
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Senior & Graduate	Prerequisite	General chemistry, General physics, Physical chemistry
This course addresses both the theoretical and the practical aspects of electrochemistry with a focus on the implementation of the electrochemistry to the R&D of various energy conversion/storage systems including rechargeable batteries, fuel cells, and solar energy systems. The first half deals with thermodynamics, kinetics, and mass transport phenomena related to electrochemistry. The send half introduces the voltammetry, impedance technique, and electrochemical aspects of batteries, fuel cells, and solar cells. This course is designed for both the senior level of undergraduate and the beginner level of graduate students			

Course Number	ES621	Course Title	Instrumental Analysis for Energy Materials
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(2), Lab(1)
Aimed Students	Senior & Graduate	Prerequisite	General chemistry, General physics, Physical chemistry
This course is designed to teach both the senior level of undergraduate and the beginner level of graduate students about various aspects of advanced characterization techniques for energy materials such as batteries, fuel-cells and solar cells. It will include topics as electron microscopic tools such as SEM and TEM, diffraction (X-ray/neutron/electron diffraction), spectroscopic methods such as UV/VIS, solid state NMR, ESR, XANES and EXAFS, thermogravimetric analysis (TG/DTA/DSC), magnetic analysis, ESCA, TOF-SIMS, ionic/electrical conductivity measurement, and introductory electrochemical characterization methods (CV, charge/discharge).			

Course Number	ES622	Course Title	Chemistry of Nanomaterials
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Senior & Graduate	Prerequisite	None
This course covers the design, synthesis, and characterization of nanomaterials for electrooptic devices. In addition, thermal, optical, magnetic, and electronic properties of nanomaterials will be discussed. Finally, emerging applications using nanomaterials will be presented.			

Course Number	ES623	Course Title	X-ray Crystallography for Materials Science
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Graduate	Prerequisite	None
The course is designed for students who study materials sciences and desire to acquire basic crystallographic knowledge, mathematical foundations of diffraction principles, computer software, and crystal structure determination. The course provides the concepts of crystallographic analysis including point/space group symmetry, the use of reciprocal lattice to understand diffraction by crystals as well as powder, and crystallographic experiment design.			

Course Number	ES624	Course Title	Diffraction and Crystal Structure
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Graduate	Prerequisite	None
The course is designed for students working on crystalline solid-state materials of inorganic network or molecular structures. The course provides the knowledge of typical crystal structures of the materials, crystal symmetry, the principles of (X-ray, neutron and electron) diffraction, and practical methods of structure determination. Principles and practical analytical methods of powder X-ray diffraction data are also covered, including Rietveld refinement techniques.			

Course Number	ES700	Course Title	Advanced Electrochemistry
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Graduate	Prerequisite	Electrochemistry
This course is designed for the senior level of graduate students, who need detailed knowledge on electrochemistry beyond the basic level. More fundamental understanding will be made on the principles of electrochemistry. Practical aspects of laboratory experiments and techniques will be covered to provide substantial helps students implementing electrochemistry to their research area. Recent progresses in electrochemistry will be also introduced to update relevant knowledge.			

Course Number	ES701	Course Title	Materials for Fuel Cells
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Senior & Graduate	Prerequisite	None
A fuel cell is an electrochemical device that converts the chemical energy of a reaction (between fuel and oxidant) directly into electricity. Given their efficiency and low emissions, fuel cells provide an important alternative to power produced from fossil fuels. A major challenge in their use is the need for better materials to make fuel cells cost-effective and more durable. This course aims at delivering a fundamental understanding of the function and importance of materials used in fuel cells (PEMFC, MCFC, SOFC). This course also deals with the fuel cell materials properties and components. Introduction to the principles and operation of fuel cells, stack configurations and fuel cell systems design will be discussed. Electrochemistry of fuel cells, introduction to electrochemical kinetics, transport-related phenomena will also be discussed.			

Course Number	ES703	Course Title	Electrocatalysis to Fuel Cells
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Graduate	Prerequisite	None

This course intends to provide a fundamental basis of electrocatalytic processes (oxygen reduction, hydrogen oxidation) in fuel cells. The important electrocatalytic principles governing their mode of operation will be described. This course will describe basics and advanced applications of catalysis in fuel cells, types, efficiencies, and catalysts requirements. Recent advancements in the development of electrocatalysts will be described.

Course Number	ES705	**Course Title**	Biofuel Cell Technology
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(3)
Aimed Students	Graduate	**Prerequisite**	None
Fuel derived from renewable resources present an attractive alternative to petroleum, with benefits ranging from reduced green house gases to reduced dependency on foreign oil. This course provides students with an overview of the cellulose ethanol production process from biomass feedstock to finished product. The course reviews cellulose based biomass that can be pretreated and converted into biofuel. Also aims to introduce direct glucose fuel cells, which could use as sustainable power supply for long term implants, converting the chemical energy to electrical energy. Direct electron transfer, mediated electron transfer biofuel cells will be discussed. Enzymatic and non-enzymes based bioelectrocatalysis will be introduced.			

Course Number	ES721	**Course Title**	Electrochemical Technology
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(3)
Aimed Students	Graduate	**Prerequisite**	Electrochemistry
The present commercial applications of electrochemical technology are many and diverse. This course introduces the practical steps essential to implement electrochemical technology on the commercial and the industrial applications. The topics will include electrosynthesis, recycling, corrosion, environmental treatment, bio/chemical sensors. This course is designed for the senior level graduate students.			

Course Number	ES723	**Course Title**	Electrochemical Energy Conversion & Storage
Credit	3	**Course Type & Hours**	Theory(3)

		('Theory',' Lab', 'Theory&Lab')	
Aimed Students	Graduate	**Prerequisite**	Electrochemistry
This course is designed to teach graduate students about fundamental principles of various batteries for electrochemical power conversion and storage devices. It will include topics as introductory electrochemical characterization technologies, overview of primary and secondary batteries, detailed understanding of electrochemistry of batteries such as zinc–carbon, heavy duty zinc chloride, alkaline, silver oxide, mercury oxide, Zinc–air , Mg-air, Al-air, and lithium batteries (primary batteries) , Lead–acid, Nickel–cadmium, Nickel–Metal Hydride, rechargeable alkaline, Lithium-ion, sodium–sulfur, sodium molten-salt, redox flow (V, ZnBr), Lithium–sulfur, rechargeable metal-air, rechargeable Mg, and sodium-ion batteries (Secondary).			

Course Number	ES724	**Course Title**	Special Topic on Li-ion Batteries
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(3)
Aimed Students	Graduate	**Prerequisite**	Electrochemistry
This course deals with fundamental principles and R&D trends on the secondary Li-ion batteries. This course aims for delivering from basic to practical up-to-date knowledge in the related academic and industrial fields. Firstly, four major components of Li-ion batteries: cathode, anode, electrolyte, and separator will be dealt with an emphasis. The brief addresses on design and test of Li-ion batteries will be followed. Finally, the R&D trend of post Li-ion batteries as well as other types of secondary batteries will be discussed. This course is designed for the beginner level of graduate students.			

Course Number	ES725	**Course Title**	Computational Design of Energy Materials
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(2), Lab (1)
Aimed Students	Senior & Graduate	**Prerequisite**	Elements of quantum mechanics, thermodynamics, chemistry, Physics, Kinetics are desirable. Computer programming skill is NOT a prerequisite.

The course introduces modern computational methods standing on quantum mechanics to graduate and senior students. Specifically, the lecture aims at guiding students to understand:
(1) What materials modeling and simulation techniques are
(2) How to utilize the methods to predict and design novel energy materials.
To achieve the objectives, the course covers elements of quantum mechanics, statistical mechanics, Monte Carlo simulations etc. In addition to lectures, students will take practices through lab sessions by applying the methodologies to energy materials for fuel cells, batteries and solar cells.

Course Number	ES726	**Course Title**	Electrode Materials for Rechargeable Batteries
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(3)
Aimed Students	Graduate	**Prerequisite**	None
The course is designed to teach about the positive and negative electrode materials for modern rechargeable batteries such as lithium ion batteries as well as emerging post lithium ion batteries. This will cover basic principles of electrochemistry for rechargeable batteries, syntheses, crystal structures, and physicochemical properties of the materials, as well as various characterization methods.			

Course Number	ES740	**Course Title**	Solid State Physics
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(3)
Aimed Students	Senior & Graduate	**Prerequisite**	Introductory quantum mechanics, Physical chemistry
This class discusses the origin of electrical, magnetic and optical properties of solids, focusing on the quantum mechanics. It encompasses materials from a hydrogen atom, simple molecules and bonds to solids with their energy bands. This class will teach atomistic level differences among metals, semiconductors and insulators. The operating principles of common devices such as transistors, magnetic storage media, and optical fibers will be explained by the class.			

Course Number	ES741	**Course Title**	Solid State Chemistry
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(3)
Aimed Students	Senior & Graduate	**Prerequisite**	General chemistry, General physics, Physical chemistry
This course is designed to teach both the senior level of undergraduate and the beginner level of			

graduate students about various aspects of solid-state materials and their application to engineering systems, with an emphasis on energy-related materials such as batteries, fuel-cells and solar cells. It will include topics as synthesis, crystal structures of the major inorganic families, introductory X-ray and neutron crystallography, electron microscopy, bonding, defects, disorder, phase transition, ionic mobility, electrical/magnetic/optical properties and intercalation.

Course Number	ES742	**Course Title**	Surface Engineering and Thin Film Technology
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(3)
Aimed Students	Graduate	**Prerequisite**	None
This course covers vacuum processed deposition techniques and solution processed coating techniques for fabrication of thin film devices. Principles and process engineering of physical vapor deposition(PVD) and chemical vapor deposition techniques(CVD) will be presented. In addition, various solution-processable coating and printing technologies will be discussed.			

Course Number	ES743	**Course Title**	Advanced Material Chemistry for Photovoltaics
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(3)
Aimed Students	Graduate	**Prerequisite**	None
This course will cover materials chemistry for various solar cells. Materials and device processing for crystalline and polycrystalline solar cells will be discussed. Materials for thin film solar cells such as CIGS(Copper-indium-gallium-selenide) and CdTe(cadmium tellulide) solar cells will be introduced.			

Course Number	ES744	**Course Title**	Spectroscopy
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(3)
Aimed Students	Graduate	**Prerequisite**	None
This course introduces the students to a wide range of spectroscopy techniques for characterization of organic and inorganic materials. It provides principles and instrumentations of various spectroscopies such as ultra violet/visible(UV/Vis), infra-red(IR), raman, photoluminescence, nuclear magnetic resonance(NMR), and mass spectroscopies. In addition, it will be presented how information from spectroscopic measurements may be applied to the determination of chemical structures.			

Course Number	ES748	Course Title	Advanced Optoelectronic Materials & Devices
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Graduate	Prerequisite	None
This course will cover chemistry and materials, fundamental physics, device processing, device fabrication, device physics, and applications of optoelectronic devices such as light-emitting diode(LED), organic light-emitting diode(OLED), and solar cells.			

Course Number	ES750	Course Title	Advanced Thin Film Photovoltaics
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Graduate	Prerequisite	None
This course covers a wide range of scientific and technological knowledge of thin film solar cells such as CdTe, CIGS, and CZTS solar cells. Materials, device physics, and device fabrication engineering for thin solar cells will be discussed. In addition, large-area module techniques for practical solar cells will be presented.			

Course Number	ES751	Course Title	Organic Photovoltaic Materials
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Graduate	Prerequisite	None
This course will cover chemistry and materials, fundamental physics, device processing, device fabrication, device physics, and applications of organic photovoltaic devices such as polymer solar cells and dye-sensitized solar cells. In addition, organic electronics and printing technologies will be discussed in the course.			

Course	ES760	Course Title	Environmental Chemistry

Number			
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Graduate	Prerequisite	None
Fundamental and advanced environmental chemistry is studied including, reaction kinetics, thermodynamics, equilibrium chemistry, acid-base chemistry, oxidation and reduction, and electrochemistry related to natural and environmental processes.			

Course Number	ES762	Course Title	Climate Changes
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Graduate	Prerequisite	None
This course will be an intense study of climate change. The emphasis will be on modern climate change, anthropogenic forcing and measured and predicted consequences of this forcing. To understand modern climate change and predictions, it is necessary to develop an understanding of natural climate forcing, natural variability and feedbacks in the climate system. To this end we will be concurrently studying the earth's climate history, and modern climate change.			

Course Number	ES764	Course Title	Environmental Policy of Energy
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Graduate	Prerequisite	None
This course provides an overview of climate change policy at the international, domestic, and local levels, with a focus on the close relationship between climate change and energy use. Topics include: climate science basics; climate change impacts and adaptation; climate policy mechanisms including regulation, subsidies, taxes, and emissions trading; history of the Kyoto Protocol, E.U. Emissions Trading System, and U.S. climate policy; climate equity and the rights of developing countries; and			

the role of different energy technologies in generating and reducing greenhouse gas emissions.

Course Number	ES765	**Course Title**	Introduction to Electric Power Systems
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(3)
Aimed Students	Graduate	**Prerequisite**	None
The demand for control of electric power of electric motor drive systems and industrial controls existed for many years. Power electronics have already found an important place in modern technology and are now used in a great variety of high-power products, including heat control, light controls, motor controls, power supplies, vehicle propulsion systems, and high-voltage direct-current systems. This course will deal with the basic concept and applications of power electronics.			

Course Number	ES766	**Course Title**	Solar Energy Applications
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(3)
Aimed Students	Graduate	**Prerequisite**	None
A general introduction to solar energy including active, passive and photovoltaic systems. Applications of technology and systems to residential, industrial and consumer electronics markets. Theory of solar radiation transmission, absorption and reflection. Heat transfer in solar energy devices. Design methods for heating of buildings with solar energy. Active and passive solar applications.			

Course Number	ES767	**Course Title**	Geothermal Energy
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(3)
Aimed Students	Graduate	**Prerequisite**	None
This course deals with technology by which the deep and shallow underground thermal environment is utilized for the thermal power generation and above ground air conditioning system. It introduces the worldwide trend of geothermal energy development and the evaluation of the status of Korea on this matter in terms of technology and social and economical conditions.			

Course Number	ES769	Course Title	Electrochemical Energy System
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Graduate	Prerequisite	None
This course is designed to provide graduate students with the ability to identify and solve practical electrochemical energy system design problems. It develops and utilizes specialized engineering knowledge and skills from a number of disciplines. It also emphasizes group project activity, competence in writing technical reports, and oral communication of analysis and design results. The application of classical, computational, and experimental methods and analyses to the design of electrochemical energy systems. Topics include design and analysis of static and transient fuel cell, electrode, bipolar, MEA, and system operational modes.			

Course Number	ES770	Course Title	Smart Grids and Electric Energy Systems
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(3)
Aimed Students	Graduate	Prerequisite	None
This course is designed to familiarize students with current and future smart grid and electric energy systems for heat, power and transportation, and to provide instruction on the analysis and design of these systems for environmental sustainability. The focus is on smart grid systems such as generation, transmission, and distribution, but also included are concepts for transforming traditional fossil fuel and nuclear systems into environmentally acceptable power systems to generate the electric energy.			

Course Number	ES800	Course Title	Special Topics I - Fuel cells
Credit	Varies	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory
Aimed Students	Graduate	Prerequisite	None
This course aims to introduce students to the recent research activities in the area on Fuel cells but not limited to any particular fuel cells. This course will introduce all recent advancements in development of catalyst, membrane, system and stack engineering. Hybrid materials for fuel cells, regenerative fuel cells or novel energy systems closely related to fuel cells will also be discussed.			

Course Number	ES801	Course Title	Special Topics II - Batteries
Credit	Varies	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory
Aimed Students	Graduate	Prerequisite	Special Topic on Li-ion Batteries
This course is intended to complement the course **Special Topic on Li-ion Batteries**, run almost annually in ESE department in DGIST. The present challenges and possible solutions of present Li-ion batteries will be sought by thorough survey of the research papers and reports. The perspectives and future direction of the energy storage devices other than Li-ion batteries will also be dealt with a higher level of depth and scope. This course is designed for the senior level graduate students.			

Course Number	ES802	Course Title	Special Topics III - Photovoltaics
Credit	Varies	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory
Aimed Students	Graduate	Prerequisite	None
This course provides materials, device physics of various solar cells such as silicon, CdTe, CIGS, polymer, dye-sensitized, or quantum-dot solar cells. In addition, the device fabrication process for various solar cells and modules will be discussed in the course.			

Course Number	ES803	Course Title	Special Topics IV - Environment
Credit	Varies	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory
Aimed Students	Graduate	Prerequisite	None
This course is designed to learn the essential principles used in environmental engineering and understand important issues in environmental engineering and pertinent environmental legislations. The focus is on the design processes for treatment of environmental pollutants, and also learns the physical, chemical and biological principles of environmental engineering. Students learn not only hazardous wastes, risk assessment and treatment technologies, but also learn indoor air pollution and control, as well as a global atmosphere change. At the end, students are 1) familiar with environmental treatment technologies and design processes, and 2) able to apply their theoretical			

knowledge to and conduct analysis on a broad variety of environmental problems.

Course Number	ES804	**Course Title**	Special Topics V – Energy Systems
Credit	Varies	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory
Aimed Students	Graduate	**Prerequisite**	None
Analysis and design of energy systems, and exploration of concepts such as carbon capture and sequestration for making traditional energy systems more environmentally acceptable. This course is designed to familiarize students with current and future energy systems for heat, power and transportation, and to provide instruction on the analysis and design of these systems for environmental sustainability. The focus is on energy systems such as geothermal, solar and wind power, battery, and fuel cell but also included are concepts for transforming traditional fossil fuel systems into environmentally acceptable power systems.			

Course Number	ES810	**Course Title**	Collaborative Topics on Fuel cells
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(1), Lab(2)
Aimed Students	Graduate	**Prerequisite**	None
This class aims at teaching convergence activity of different research areas in fuel cells. It is organized by inviting guest lecturers for fuel cell materials (membranes, Catalysts etc.) and stacking and design of whole systems. Students will learn frontier research topics in such detailed fields and operating principles of fuel cells with many materials assembles into one device.			

Course Number	ES820	**Course Title**	Collaborative Topics on Batteries
Credit	3	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Theory(1), Lab(2)
Aimed Students	Graduate	**Prerequisite**	Electrochemistry
The course comprises a combination of lectures of the several experts. The lecturers will be selected not only from the professors in universities, but also from research institutes and industry fields, if they are currently working actively in the battery field. This course will provide most updated R&D status and the state-of-the-art knowledge on the battery-related issues. This course is designed for the senior level graduate students.			

Course Number	ES840	Course Title	Collaborative Topics on Photovoltaics
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(1), Lab(2)
Aimed Students	Graduate	Prerequisite	None
This course covers recent research progress of the second generation solar cells which are the thin film solar cells such as a-silicon, CdTe, CIGS, CZTS solar cells. In addition, materials and device physics of the next generation solar cells such as OPVs (organic photovoltaics), DSSSs (dye-sensitized solar cells), QD (quantum dot) solar cells will be discussed in the course.			

Course Number	ES860	Course Title	Collaborative Topics on Environment
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(1), Lab(2)
Aimed Students	Graduate	Prerequisite	None
Current research, practice, and thinking in environmental engineering and science. Special collaborative topic features presentations by invited speakers and enrolled students. Students will prepare and give two short presentations, and will be provided feedback on presentation skills. For unit option, students will write summaries of presentations by invited speakers. Throughout the academic year, students will have chance to learn and interact with prominent scholars invited to give a seminar. From this course, students will familiarize themselves with topics in environmental engineering and up-to-date approaches to solving environmental problems. At the end, student will contribute to the community of scholars and engineers working towards the solution of important problems through participation in activities.			

Course Number	ES861	Course Title	Collaborative Topics on Energy Systems
Credit	3	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Theory(1), Lab(2)
Aimed Students	Graduate	Prerequisite	None
Through this course, students will learn more integrated energy systems, such as, battery, solar			

energy systems, wind energy systems, geothermal energy systems, fuel cell systems, and other renewable and traditional systems from invited scholars. Also, importance of energy management, energy auditing: methodology, analysis of past trends (plant data), closing the energy balance, laws of thermodynamics, measurements, portable and on line instruments will be covered.

Course Number	ES900 ES901	**Course Title**	Thesis(M.S.) Thesis(Ph.D)
Credit	Varies	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Lab
Aimed Students	Graduate	**Prerequisite**	permission of student's research advisor
M.S. or Ph.D. thesis research. Students will be trained for their degree by their advisors.			

Course Number	ES902 ES903	**Course Title**	Capstone(M.S.) Capstone(Ph.D)
Credit	Varies	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Lab
Aimed Students	Graduate	**Prerequisite**	permission of student's research advisor
The capstone course is an opportunity for students to demonstrate that they have achieved the goals for learning and training established by the department.			

Course Number	ES904 ES905	**Course Title**	Internship(M.S.) Internship(Ph.D)
Credit	1	**Course Type & Hours ('Theory',' Lab', 'Theory&Lab')**	Lab(1)
Aimed Students	Graduate	**Prerequisite**	None
An important common course of the Energy Systems Engineering Department is "Internship" of participation in Lab Exploration Rotations. Participation in three research exploration rotations is required for all first year Energy Systems Engineering students. This course serves several purposes: 1. to help students choose their academic advisor (professor) and to help professors choose their proper graduate students; 2. to provide students an opportunity to actively participate in current research projects			

Course	ES906	**Course Title**	Seminar(M.S.)

Number	ES907		Seminar(Ph.D)
Credit	1	Course Type & Hours ('Theory',' Lab', 'Theory&Lab')	Lab (1)
Aimed Students	Graduate	Prerequisite	None
The main purpose of this weekly seminar is to introduce various research topics of current developments and motivate the student's interest in energy systems engineering. These seminars will be delivered by eminent scientists across from the world and to share their knowledge with our department students. This weekly seminar will provide students a broad understanding of current research activities in fuel cells, solar cells, and secondary ion batteries and not only that it will also promote the exchange of scientific ideas and findings among members of the Energy systems engineering, and create more opportunities for students.			