SEM-SEM

Smart Control Systems for Energy Management

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Muta'h University/Faculty of Engineering

Industrial Systems Engineering Department

A Masters Program-National track

Engineering management / Smart systems Energy Management (S.S.E.M)

2016-2017

National Track

Contents:

1- INTRODUCTION

1-1 The Value of Energy Management

Business, industry and government organizations have all been under tremendous economic and environmental pressures in the last few years. Being economically competitive in the global marketplace and meeting increasing environmental standards to reduce air and water pollution have been the major driving factors in most of the recent operational cost and capital cost investment decisions for all organizations. Energy management has been an important tool to help organizations meet these critical objectives for their short term survival and long-term success.

Energy management reduces the load on power plants as fewer kilowatt hours of electricity are needed. If a plant burns coal or fuel oil, then a significant amount of acid rain is produced from the sulfur dioxide emitted by the power plant. Acid rain problems then are reduced through energy management, as are NOx problems. Less energy consumption means less petroleum field development and subsequent on-site pollution

1-2 Typical Savings through Energy Management

Large savings can be accomplished often with high returns on investments and rapid paybacks through:-

1) Energy Management can make the difference between profit and loss and can establish real competitive enhancements for most companies.

2) Energy management in the form of implementing new energy efficiency technologies, new materials and new manufacturing processes and the use of new technologies in equipment and materials for business and industry is also helping companies improve their productivity and increase their product or service quality

3) The combination of increased productivity, increased quality, reduced environmental emissions, and reduced energy costs provides a powerful incentive for if energy productivity is an important opportunity for the nation as a whole, it is a necessity for the individual company. It represents a real chance for creative management to reduce that component of product cost that has risen the most since 1973. Those who have taken advantage of these opportunities have done so because of the clear intent and commitment of the top executive.

4) Once that commitment is understood, managers at all levels of the organization can and do respond seriously to the opportunities at hand. Without that leadership, the best designed energy management programs produce few results.

5) Expand the effectiveness of existing energy management programs or provide the starting point of new efforts through *controlling the costs of the energy function or service provided, but not the Btu of energy.*

1-3 The Energy Management Profession

Energy management skills are important to people in many organizations, and certainly to people who perform duties such as energy auditing, facility or building management, energy and economic analysis, and maintenance.

The number of companies employing professionally trained energy managers is large and growing. A partial list of job titles is given in job title. Even though this is only a partial list, the breadth shows the robustness of the profession.

1-4 Typical Energy Management Job Titles

• Plant Energy Manager
• Building/Facility Energy Manager
• Utility Energy Auditor
• Utility Energy Analyst
• State Agency Energy Analyst
• Government Energy Analyst
• Consulting Energy Manager
• Consulting Energy Engineer
• DSM Auditor/Manager (DSM= Demand Side Management)

1-5 For Permanent Energy Management Solution

• There is a direct economic return. Most opportunities found in an energy survey have less than a two year payback. Some are immediate, such as load shifting or going to a new electric rate schedule.

• Most manufacturing companies are looking for a competitive edge. A reduction in energy costs to manufacture the product can be immediate and permanent. In addition, products that use energy, such as motor driven machinery, are being evaluated to make them more energy efficient, and therefore more marketable. Many countries where energy is more critical, now want to know the maximum power required to operate a piece of equipment.

• Energy technology is changing so rapidly that state-of-the-art techniques have a half life of ten years at the most. Someone in the organization must be in a position to constantly evaluate and update this technology.
• Energy security is a part of energy management. Without a contingency plan for temporary shortages or outages, and a strategic plan for long range plans, organizations run a risk of major problems without immediate solutions.
• Future price shocks will occur. When world energy markets swing wildly with only a five percent decrease in supply, as they did in 1979, it is reasonable to expect that such occurrences will happen again.

2-Program Objectives:

This program is to deliver the following objectives:

a) The main objectives:

1) A master program serving the area of smart systems of energy management using smart Environment, in addition to an embedded professional engineering degree
2) Establishment of a Transfer Technology Center (TTC) to transfer the knowledge Triangle of education-innovation-research in area of energy as well as for develops Engineering and technicians
3) Providing a group of training courses in the field of smart control systems and energy Management that should serve engineers and technicians as well

b) The Specific Objectives:

M.Sc program will be tackling a problem found and raised by the industrial society, which will be new and innovative.
- The main aim is to reduce the energy consumed by their working processes.
- From this point of view the program is divided into two modules:

1) **Management and smart Control Systems**

It will develop graduate engineers with knowledge of different control systems.

These graduated will be able to manage and optimize the operation between different control systems.

2) **Management of Industrial Mechanical Systems**

It will deliver graduates with the skills of design and construct new sustainable energy systems.

Graduates will be able to evaluate the performance and efficiency of current and future energy systems.

Graduates will have the skills to evaluate the integration of sensors, actuators and networking to updated equipment used at their working process
Establishment of a Technology Transfer Centre (TTC) which supports the research and training cooperation between the Jordanian, Egyptian and European partners. The centre will be responsible for bridging the knowledge triangle education-innovation-research between industry and academia

3-The Program outcomes

The new M.Sc program (S.S.E.M) will be between Egyptian, Jordanian and European Universities partner, program is divided into two modules:

i) Automation Mechanical Systems

ii) Management and Control Systems.

The two modules will be designed for developing the top two levels of automation pyramids (i.e. Manufacturing Execution System and Enterprise Resource Planning) which are not available until now in any of other higher education programs at Middle East. The M.Sc degree curriculum shall be developed according with the Bologna Convention (3 cycle structure, ECTS, and degree recognition).

iii) The Automated Mechanical Systems will deliver graduates with the skills of evaluating the performance and efficiency of current and future smart systems of energy management. They will be able to design and construct new sustainable energy management systems. They will have the skills to evaluate the integration of wireless communication, sensors, actuators and networking to updated equipments used at their working processes.

4- Needs for the program

1) Demand increase on energy in all sectors i.e., residential, governmental, industrial sector
2) Emerging technologies in energy production and energy efficiency
3) Globalization and market interactions, national and international energy business
4) Proficiently qualified energy mangers are not available locally or in region
5) The program will contribute to the university progress in academic research and community
6) Energy is the driving engine of economy, 10-30% of the national GDP is the share of Energy in
Jordan.

5-Human Resources

5-1 Engineering Faculty Members High qualified faculty members at all the respective engineering departments are uniquely. Prepared to teach and to supervise students

5-2 Lab Technicians
Current Lab Technicians at all the engineering departments are more than enough to run the needs of the program

5-3 Expected numbers of students applying to the proposed program

The information of the following table is based on market needs,

	First Year	**Second Year**	**Third Year**	**Fourth Year**	**Fifth Year**
Masters Program	20	30	35	40	40

6- Facilities: Libraries, computer labs, and software

University library is available and currently open which contains all the related references up to date. There are more than computer lab will serve the program in addition there is a professional one.

7- Cooperation and Partnering with other Universities and Programs

The program is intended to be an efficient environment for university-community outreach activities, training, and the courses offered through the program will connect students to real projects, problems, and case studies. Professionals from different governmental agencies and industries are expected to participate in the educational and research activities of the program. The program will seek cooperation with other graduate programs

8- Program Partners:

a) EU Partners:

- Staffordshire University (SU) (UK)
- University of OVIEDO (UNIOVI) (Spain)
- Institute Superior Technical (IST) (Portugal)
- University of Cyprus (UCY) (Cyprus)
- Euro training Educational Organization (Greece)

b) EG Partners:

- Arab Academy for Science Technology and Maritime Transport (AASTMT)
- Ain Shams University (ASU)
- Nile University (NU)
- Helwan University (HU)
- Alexandria co. For Seeds Processing and Derivation (ALEXSEEDS)

c) JOR Partners:

- University of Jordan (U.J)

- Mutah University (MU)
- Jordan University of Science and Technology (JUST)

9- **Study Plan:**

MASTER in Smart Systems Energy Management (S.S.E.M):-

A) General Rules and Conditions:

1. This plan conforms to the regulations of the general framework of the programs in graduate studies

at Mutah University.

2. Areas of specialty for admission to the M.Sc. Program:

- Holders of the bachelor's degree in:

- Industrial systems engineering
- Mechanical Engineering,
- Chemical Engineering,
- Electrical Engineering.
- Architecture Engineering
- Civil Engineering
- computer Engineering
- Mechatronics Engineering

B) The Study Plan: Studying (33) Credit Hours as Follows: -
Thesis Track

1. Obligatory Courses: (15) Credit Hours:

Studying from the following:

Course No.	Course Title	Credit hrs.	Pre-req.
0406731	Modeling and Simulation of Production Systems	3	0402302
0406721	Advanced Operation Research	3	0402302
0406724	Research methodology	3	0402302
0406850	Energy Management Systems*	3	
0406851	Fault Tolerance Control for smart systems	3	
04068 85	Thesis	9	

2. **Elective courses: Studying (9) Credit Hours from the following:**

Course No	Course Title	Credit hrs.	Pre-req.
0406752	Risk Management	3	
0402801	Advanced Engineering Mathematics (Partners)	3	
0406853	New technologies in HVAC (Mutah)	3	
0406722	Total quality management	3	0402302
0406854	Energy saving in Apparatus#	3	
0406755	Waste Heat Recovery (Mutah)	3	

0406856	Waste management[#]	3	
0406857	Fundamentals of HVAC Systems[#]	3	
0406858	Industrial Project Management (Partners)	3	
0406859	Mechanical Machines design	3	
0406860	Power Station systems design (Mutah)	3	
0406747	Production management [#]	3	0402302
0406749	Maintenance Management and Applications	3	
0406861	Energy Management[#]	3	
0406862	Energy Conservation and Renewable Energy [#]	3	
0406867	Thermal energy systems (Partners)	3	
0406868	Iso 5001- Energy management systems (Partners)	3	
0406866	Energy Quality Systems (Partners)	3	
0406853	Optimal energy Management Systems [#]	3	
0406746	Cost estimation and control for engineers	3	
0406865	Energy Environmental Impact [#]	3	

<u>Comprehensive Track</u> (None Thesis Track):-

1. **Obligatory Courses: (24) Credit Hours:**

Studying from the following:

Course No.	Course Title	Credit hrs.	Pre-req.
0406731	Modeling and Simulation of Production Systems	3	0402302
0406721	Advanced Operation Research	3	0402302
0406724	Research methodology	3	0402302
0406850	Energy Management Systems	3	
0406851	Fault Tolerance Control for smart systems*	3	
0406722	Total quality management	3	
0406853	New technologies in HVAC	3	
0406855	Waste Heat Recovery	3	

2. **Elective courses: Studying (9) Credit Hours from the following**:

Course No	Course Title	Credit hrs.	Pre-req.
0406752	Risk Management	3	
0402801	Advanced Engineering Mathematics	3	
0406854	Energy saving in Apparatus#	3	
0406856	Waste management#	3	

0406857	Fundamentals of HVAC Systems#	3	
0406858	Industrial Project Management	3	
0406859	Mechanical Machines design	3	
0406860	Power Station systems design	3	
0406747	Production management #	3	0402302
0406749	Maintenance Management and Applications	3	
0406861	Energy Management#	3	
0406862	Energy Conservation and Renewable Energy #	3	
0406867	Thermal energy systems	3	
0406868	Iso 5001- Energy management systems	3	
0406866	Energy Quality Systems	3	
0406853	Optimal energy Management Systems #	3	
0406746	Cost estimation and control for engineers	3	
0406865	Energy Environmental Impact #	3	

Pre-Request: **(0402302)** Probability and statistic

Courses Description:

(0406721) Advanced operations research (3 credit hours):

The objective of this course is to expose the student to different topics in operations research like linear programming, introduction to nonlinear programming, and decision analysis techniques.

(**0406731) Modeling and simulation of production systems (3 credit hours):**

The course aims to introduce students to concepts of production systems modeling and simulation, to enhance student skills in system modeling by using a simulation language to convert real systems into computer simulation models with the objective of analyzing these systems to achieve the best possible to optimize system productivity and effectiveness.

(0406740) Special topics in engineering management (3 credit hours):

The objective of this course is to expose the student to recent developments in certain areas. In addition, the student is expected to study some field problems and gets to learn how to find the appropriate solutions for it.

(0406746) Cost estimation and control for engineers (3 credit hours)

The aim of this course is to analyze the cost estimation and quantity surveying for construction organizations. Analyze the integration or the relationship between cost estimation and time and engineering bid preparation, estimations of labor and equipments. Cost control, change orders and claims in different engineering projects.

(04067747) Production management (3 credit hours)

This course introduces students to practical concepts and methods existing in production systems including industrial and service systems. It focuses on production methods and operations that are used in converting the different production systems inputs into outputs. This includes material requirement planning and control, scheduling of production operations, facility planning, forecasting methods, and productivity improvement, The course also introduces basic principles and methods used in production quality management such as quality assurance systems, statistical quality control charts, quality cost and quality improvement.

(**0406749) Maintenance Management and Applications (3 credit hours)**

This course aims to introduce the basic concepts and principles of management, maintenance organization, maintenance policies in production systems, condition based maintenance applications, simulation (Monte Carlo) of maintenance function in Queuing systems, network maintenance projects, control of spare parts and equipment.

(**0406856) Waste management (3 Credit hours)**

Introduction to the course organization. Discussion of the evaluation process. Preliminary list of the possible themes for the monographic work and presentation.

Overview of the various possible themes to be chosen by the students. Groups' setting up.

Societal challenges in the XXI century. The Waste Scenario - The human factor. Waste and Energy scenarios overview.

Waste Management - Historical Perspective. Waste management throughout history. Evolution of the London waste management system as a case study. Emergence of waste-to-energy applications. Similarities between the current situations.

Waste Management Today. Overview on waste management worldwide.

Waste generation throughout the production process - from mining to final disposal - the linear economy. Difference in waste composition and management systems in different countries. International regulations on waste. Waste management hierarchy. Reduction, reuse, recycling and energy recovery in the cycle of resource management and contribution to a circular economy

Energy Recovery Routes. Issues associated with waste management - collection, sorting, etc...Situation in waste generation and waste management in different parts of the world, with a focus on EU. Land filling, incineration and recycling as the most relevant ways today - situation in Europe and perspectives. Waste-to-Energy in the context of waste management. Different options for the various types of waste generated.

Environmental and Social Aspects. Waste policy and WtE plants in Europe. Contribution of Waste-to-Energy plants at the environmental and social levels.

Introduction to the methodology of Life Cycle Assessment. Phases of LCA, definition of scope and boundaries, collection of information and inventory, impact calculation,

and interpretation. Application to waste management and recycling - open-loop and closed-loop recycling. Scope variations: Craddle-to-Grave, Craddle-to-Gate, etc... Examples of impact categories. Case study examples: Vancouver waste management report; Bank note waste from the Bank of England. LCA and the construction of the waste management hierarchy.

0402801 Advanced Engineering Mathematics (3 Credit hours)

Review of ordinary differential equations, vectors and vector calculus, matrices, partial differential equations, calculus of variations, complex analysis.

0406724 Research Methodology (3 credit hours)

In this course students learn how to carry out different stages of scientific research starting from the formulation of research idea and finishing by a write up and presentation of a technical report. The course is in the form of lectures taught by faculty and invited speakers in which various types of research and different case studies in the advanced fields of energy engineering will be presented. As a part of the course, students will undertake at least one small research projects under the supervision of faculty members to learn how to define the problem and complete the literature review using various resources including the Engineering Index Journal list and other relevant internet sources. Measurement systems and instruments, acquisition of thermo fluid dynamic parameters, elements of technical design and drawing, elements of mechanical manufacturing (manufacturing devices) will be introduced.

Additionally students will gain knowledge on how to use in their projects appropriate analytical and numerical solutions and experimental methods. The general structure of their project reports will indicatively include the following sections: Abstract,

0406859 Mechanical Machines Design :(3 credit hours)

Mechanical Springs: Lubrication and Journal Bearings, Gears- General Clutches, Brakes, Couplings, and Flywheels, Flexible Mechanical Elements, Rolling -Contact Bearings.

0406861 Energy Management: (3 Credit hours)

International Organization for Standardization (ISO), which published its latest international energy management standards, the ISO 50001, in June 2011. Organizations across the world face energy-related challenges, including those related to energy supply, reliability and climate change matters. The ISO 50001

is a framework that helps companies manage their energy systems and plan better to save energy and to reduce pollution as well as costs. ISO estimates these standards can reduce global energy consumption by 60 percent.

0406851-Fault Tolerance Control for smart systems: (3 Credit hours)

Fault-tolerant control system design and analysis against sensor failures in an active suspension of a full vehicle system have been considered. Detailed mathematical description of the suspension is derived first. Based on this model, fault-tolerant control systems performance against several commonly encountered sensor failures have been investigated. The originality of the work in this chapter is the breakdown of the entire suspension system into several interconnected subsystems. Each subsystem has its own local controller and its own fault diagnostic module. A higher level control system coordinates tome most important

Concepts and procedures in fault-tolerant control system design and analysis. The authors have done this with elegance of mathematics, as well as in-depth physical understanding of the limitations of handicapped actuators and sensors. This is a must read book on the subject of fault-tolerant control systems. The logical introduction and the easy to understand styles of presentation have made this book particularly suitable for graduate students and practicing engineers who are looking for some guidance in applying active fault-tolerant control methods in their own fields of interests.

0406752 Risk Management: (3 Credit hours)

Understanding risks in today's organizations by analyzing risks using quantitative methods. Developing risk response strategies and managing projects using a Risk Management Plan (RMP). Risk identification, quantification assessment and evaluation. Loss prevention. Risk management principles and techniques. Risks control measures and industrial risks.

0406853 Optimum Energy Management systems (3 Credit hours)

Application of operation research and management techniques to the energy systems. The student is to work on a specific cases or projects and demonstrate ability to utilize existing software packages in solving real life problems. Case studies from international and local arena are to demonstrate the applicability of optimization, modeling, statistics and management to energy systems.

0406854 Energy Saving in Apparatus: (3 Credit hours)

Energy-efficient motor technologies, energy-efficient motors, energy-savings with electric drive. Advanced motor and drive technologies. Efficiency testing and standards. Policies of energy savings. Selection of energy efficient motors. Energy efficient lighting equipment and home energy savings. PF improvement

0406862 Energy Conservation and Renewable Energy (3 Credit hours)

Review of energy sources and their applications. Energy auditing. Energy conservation in industrial, commercial and household sectors. Control and energy savings. Choice of fuel. Waste heat recovery from industrial process, process. integration for efficient use of energy, selection of heat transfer equipment, and enhancement of heat transfer. Definitions and basic concepts of renewable energy. Types of renewable energy. Solar energy. Wind energy. Ocean-waves energy. Biomass and bio-energy. Geothermal energy. Theories, design, efficiency, feasibility, and application of some renewable energy systems: photovoltaic, wind energy converters, and hybrid energy systems.

0406865 Energy Environmental Impact (3 Credit hours)

Types of pollution: particulate emissions, gaseous and solid waste pollution, and thermal pollution . Effluent systems such as cyclones, wet scrubbing processes, sulfur dioxide recovery, Claus off –gas treating, NOx control by furnace and burner design. Emission monitoring systems. Environmental effects on choices of energy patterns and conversion system.

0406850 Energy Management Systems (3 Credit hours)

Power distribution systems, energy-saving measures for power distribution systems, energy diagnosis: lighting systems, measures for enhancing energy savings in the lighting
Systems, reducing energy consumption of an
Electronics factory's lighting system, energy-saving diagnosis: compressed air systems, energy-saving measures for compressed air systems, distribution system of compressors, storage systems, select control strategy matching with system load, energy diagnosis: air-conditioning and ventilation
Systems, measures for reducing power consumption of air-conditioning
And ventilation systems, direct pressure injection molder with servo system,

0406722 Total Quality Management (3 Credit hours)

The purpose of this subject is to provide a framework for the development of understanding of some of the basic aspects of Total Quality Management. The aim is to

provide students with deeper knowledge of various principles and core concepts of Total
Quality Management. It will also help them to learn and appreciate the role of measurement, quality strategy and quality systems, etc. in the development of the Total Quality Management process. This subject will also provide the readers with a basic knowledge and understanding of various aspects of the effective organizational process and quality improvement plans for the development of the required change in the process of management. I believe that
with the help of this subject students will be able to use the process specification and analysis tools to create process-oriented organizations. They will also be able to understand the need to change the management process and required motivation to create
a quality organization.

0406861 Fundamentals of HVAC Systems (3 Credit hours)

This is the Course Reader to accompany the Fundamentals of HVAC Systems online modules. To help you learn at your convenience, this Course Reader is also available to you as an eBook included with the online Course Modules. The Course Reader will provide you with background information to help you develop in-depth knowledge of the Fundamentals of HVAC Systems, to improve your skills in HVAC&R and to earn the 35 PDHs/3.5 CEUs awarded for successful completion of the Fundamentals of HVAC Systems Learning course. We look forward to working with you and helping you achieve maximum results from the course.

0406858 Industrial Project Management (3 Credit hours)

Project and project management Project Appraisal and risk management, Project management and quality, Project Appraisal and environment impact, Cost estimating in contracts and projects, Project finance, Project cash flow, Project organization, Project management and project managers, Project management and project managers, Project operations, Project control using earned value techniques, Contract strategy, Tender procedure and contract policy International projects.

0406860 Power Station System Design (3 Credit hours)

Fundamental of Power Plant, Non-Conventional Energy Resources and Utilization, Power Plant Economics and Variable Load Problem, Steam Power Plant, Steam Generator, Steam Turbine, Fuels and Combustion, Diesel Power Plant, Gas Turbine

Power Plant, Nuclear Power Plant, Hydro-Electric Power Plants, Electrical System, Pollution and its Control**,**