

King Saud University
Mechanical Engineering Department
ME 494 Selected Topics in Mechanical Engineering (Foundation of Energy Efficiency)

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Course Objectives:

Foundation of Energy Efficiency is a multi-disciplinary course that introduces energy consumption reduction measures in buildings, transportation and industrial sectors. The main objective of the course is to provide engineering and architect students with the basic principles of energy efficiency, fundamental concepts, sustainability, energy policy, energy finance and energy and environment.

Credit hours: 3 lectures, 1 hour tutorial

Prerequisites: None, preferably for students in their senior year.

Textbook: None

Reference Textbooks:

"Sustainable Energy: Choosing Among Options" by J. Tester *et al.*, 2012, 2nd Edition.

"Handbook of Energy Audits" by A. Thumann *et al.*, 2012, 9th Edition.

"Fundamentals of Thermal-Fluid Sciences" by Y. Çengel *et al.*, 2012, 4th Edition.

"Sustainable Energy - Without the Hot Air" by D. MacKay, 2009, UIT Cambridge Ltd., 1st Edition.

"Energy Efficiency Manual" by D. Wulfinghoff, 2000, Energy Inst Pr, 1st Edition.

Course Content

Week	Topic	Lecture Topic
1	Fundamental Concepts	L1: Course outline, need for energy efficiency in Saudi Arabia, and critical factors that influence energy efficiency decisions in the Kingdom
		L2: Distinction between demand and supply side energy efficiency
		L3: Energy efficiency terminology, barriers to energy efficiency, derivation of associated thermal units and inter-relationships
2	Fundamental Concepts	L4: Review of laws of thermodynamics and Carnot efficiency
		L5: Modes of heat transfer (conduction, convection, and radiation)
		L6: Basic electrical concepts in energy – current, voltage, power, energy, phases, power factor, etc.
3	Fundamental Concepts	L7: Understanding the energy supply-chain: well-head to end-user
		L8: <i>Guest Lecturers: SEEC (demand-side) and SEC (supply-side)</i>
		L9: Demand-side consumers of energy – international and domestic benchmarks
4	Building Energy Efficiency	L10: Break-down of energy in residential, commercial, and industrial buildings and introduction of concept of Energy Use Intensity.

		Equipment to monitor energy consumption – kWh-meters and smart-meters.
		L11: Lighting – types (LED, CFL, and incandescent), calculations of efficiency and standards formulation
		L12: Lighting continued
5	Building Energy Efficiency	L13: Thermal insulation – need and types based on building envelopes and setting R/U value
		L14: Appliances – concepts & advancements in technology
		L15: Air-conditioning – definitions (including EER) and psychometric charts
6	Building Energy Efficiency	L16: Air-conditioning – residential (types/technologies)
		L17: Air-conditioning – commercial and industrial
		L18: <i>Guest Lecturer: SASO on EE Standards</i>
7	Urban Planning & District Cooling	L19: Importance of urban planning and introduction of district cooling
		L20: Cooling towers, types of chillers, thermal storage, and treated sewage effluent
		L21: Combined heat & power
8	Industrial Energy Efficiency	L22: Major consumers of energy and ISO 50001
		L23: Electric motors – types, energy consumption, efficient use and setting standards
		L24: Pumps and compressors – types, applications, sizing, and methods of improving efficiency
9	Industrial Energy Efficiency	L25: Boilers – electric and gas fired boilers and MEPS
		L26: Performance benchmarking and improvement measures in petrochemical or cement industry
		L27: <i>Guest lecturer: SABIC – case-studies on energy efficiency in industry</i>
10, 11	Energy Auditing	L28,29,30: Conducting an energy audit of a building based on International Performance Measurement & Verification Protocol (IPMVP)
		L31: Concept of Energy Service Company market and types of contracts
		L32,33: Making retrofit recommendations and report writing
12	Transportation & Behavioral Energy Efficiency	L34: Types of fuel, fuel economy standards, and labeling for light duty vehicles, including TRR
		L35: Methods to improve fuel economy for heavy duty vehicles – aerodynamic additives, anti-idling, etc.
		L36: Behavioral aspects – best practices
13	Economics of Energy Efficiency	L37: <i>Guest lecturer – World Bank – case studies</i>
		L38: Economics of energy efficiency – calculation of pay-back periods and financing
		L39: Benefit to cost ratio – Kingdom and end-user
14	Energy policy and Global Programs	L40: Carbon markets and introduction to GHG
		L41: Relative performance of global energy efficiency programs
		L42: Economics of oil markets
15	Course Wrap-up	L43: Project Presentation
		L44: (buffer)
		L45: Course conclusion – review of critical learnings and discussion of final examination

Design Content: 10%

Lectures: 90 %

Laboratory Portion: None

Assessment Tools:

Homework + Quizzes: 10 %

2 Midterm Exams: 30 %

Project: 20 %

Final Exam: 40 %

Estimated ABET Category Content:

Mathematics and Basic Science: 0 credit units or 0%

Engineering Science: 3.0 credit units or 100%

Engineering Design: 0 credit units or 0%

Project:

The project shall be on conducting an energy audit on your own house (or a commercial or an industrial facility). You will need to apply the energy saving measures discussed in the class and, then, discuss the cost and benefit of every measure you propose. You will be required to submit a 10 pages report and presentation.

Learning Outcomes:

Upon successful completion of the course, students will:

1. Have an awareness of the importance of energy efficiency.
2. Recognize the terminology used in energy efficiency along with units used to quantify parameters (e.g. power) and relationship among parameters and associated units.
3. Understand the energy value chain for major drivers of energy demand and consumption in the major sectors (buildings, industry and transportation).
4. Learn about methods used to reduce energy consumption in the buildings, industry and transportation sectors.
5. Have knowledge on the business (financial and economic) aspects of energy efficiency.
6. Be adept at using equipment used to measure energy consumption of products deployed in the buildings, industrial, and transportation sectors.
7. Be familiar with global energy and energy efficiency policies.