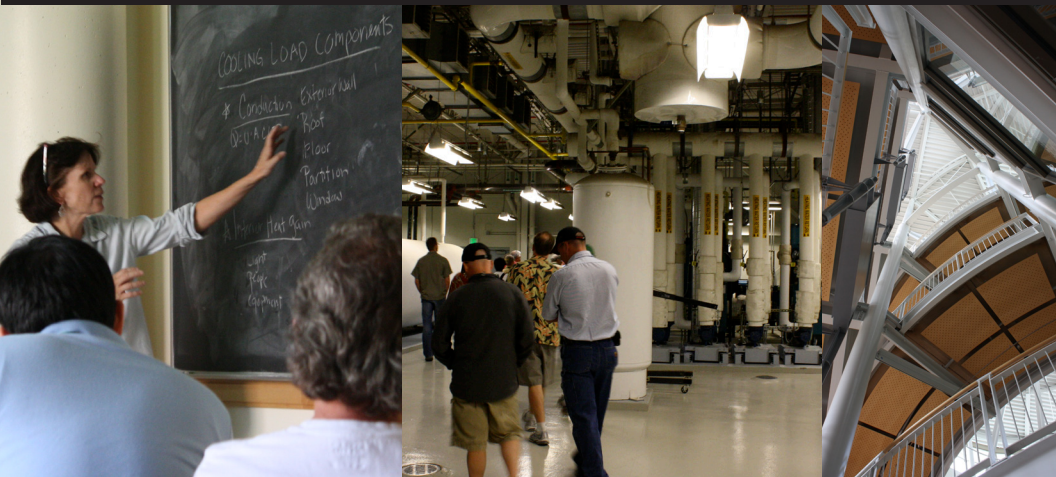


SUMMER Energy SERIES Educator

2-year EM Degree Class by Class GUIDEBOOK & NOTES



August 1st-4th, 2012

Energy Management

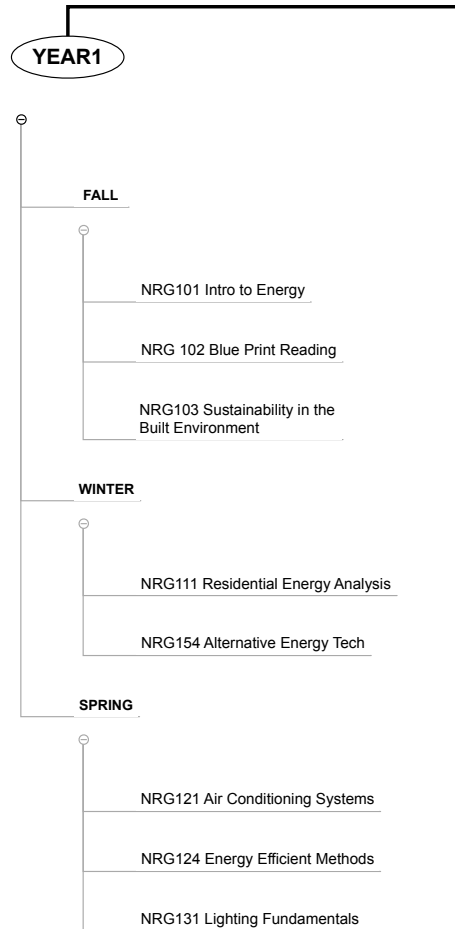
General Description

Students learn to apply basic principles of physics and analysis techniques to the description and measurement of energy in today's building systems with the goal of evaluating and recommending alternative energy solutions that will result in greater energy efficiency and energy cost savings.

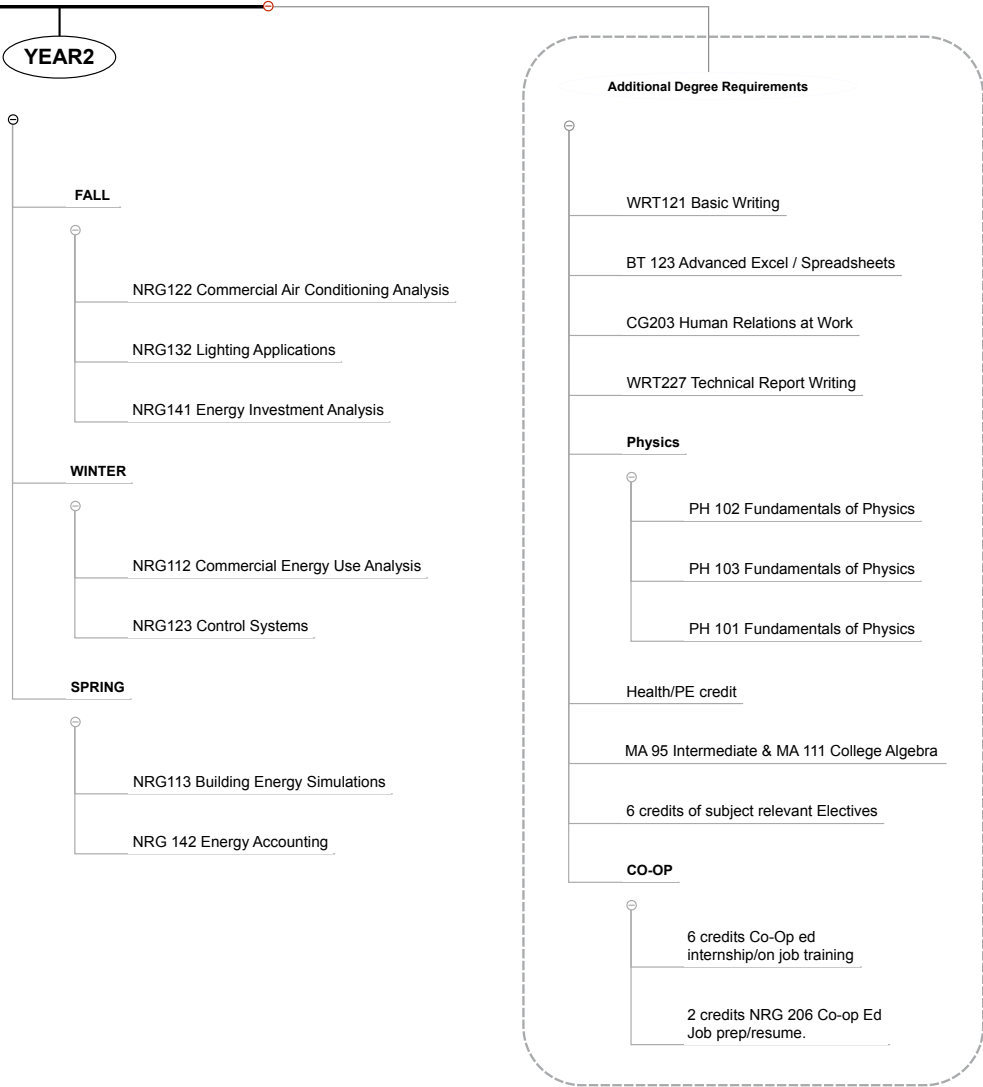
Graduates find employment in a wide variety of disciplines and may work as Facility Managers, Energy Auditors, Energy Program Coordinators or Control System Specialists, for such diverse employers as Engineering firms, Public and Private Utilities, Energy Equipment Companies, and Departments of Energy.

Overall Goals & Expectations

- * Evaluate the energy use patterns for residential and commercial buildings and recommend energy efficiency and alternative energy solutions for high-energy consuming buildings.
- * Understand the interaction between energy consuming building systems and make recommendations based on that understanding.
- * Construct energy evaluation technical reports and make presentations for potential project implementation.
- * Access library, computing and communications services, and obtain information and data from regional, national and international networks.
- * Collect and display data as lists, tables and plots using appropriate technology (e.g., graphing calculators, computer software).
- * Develop and evaluate inferences and predictions that are based on data.
- * Interpret the concepts of a problem-solving task, and translate them into mathematics.



COMPREHENSIVE 2 YEAR ASSOCIATES OF APPLIED SCIENCE DEGREE



What is this guidebook for?

One of the difficulties in creating a quality degree program is selecting the collection of classes that not only teach students specific skills but also provides them with a broader understanding of their targeted industry. At Lane Community College, we have the expertise and the historic perspective of successfully running these types of Energy and Water programs since 1980. This booklet provides an example and not the definitive rule of what a comprehensive 2-year AAS Degree program should contain.

Graduates of the 2-yr Energy Management program might find themselves in jobs where they'll be expected to:

- Conduct Energy Audits of buildings and itemize the specific type and number of every energy related component - heating, cooling and ventilating equipment, lighting system, windows, insulation, office equipment, etc . Set up datalogging equipment that monitors and records things like occupancy, lighting, and running times of equipment to collect data about the actual operation of the building.
- Use information from an Energy Audit to analyze a building's energy use and make recommendations about ways to use less energy by eliminating wasted energy, upgrading systems, improving occupant awareness, improving operations and maintenance of the building systems. Such an analysis would include the cost of the changes and the potential savings in energy and money.

For example they might conduct calculations to determine following: If the audit showed that the building was lit using older style lighting technology, how much would it cost to install new lighting technology, what would be the effect on the light levels, how much energy would it save, how much money would it save, how long would it take to pay back the investment with the money saved in energy costs?

Another scenerio - If the monitoring equipment showed that the building was being heated and cooled during unoccupied hours, how much energy and money could be saved by turning off the equipment during those times? How could this be accomplished?

- Track and analyze trends in energy use by inputting monthly utility bill data into energy management software. This might be in a job as an Energy Specialist in a school district or an organization with multiple buildings.
- Use Energy Simulation software to model, analyze and compare energy use in proposed or existing buildings . The position might be with an engineering or architectural firm.
- Administer energy incentive programs for utilities and other energy conservation organizations. Write about energy topics for Public utilities and state governments.
- Help clients apply for monetary or tax-based energy incentives through local, state and federal government programs.

(This is just a sample. There are a great number of other possibilitites as well.)

Introduction to Energy Management

EXPECTATION REGARDING COMPUTER PROFICIENCY

Nearly every course in the 2 year program requires students to use (but not necessarily own) a computer. Students are also required to log onto and use Moodle. Moodle is an online course learning management system (LMS) that can contain assignments, resources, quizzes, videos, articles, forums and more. To access Moodle you must have 1) a current email address and be comfortable using email; 2) access to a computer with high-speed internet abilities; 3) and be able to operate an internet browser such as Firefox or Internet Explorer.

CREDIT: 3

Introduction to Energy Management will provide an overview of the energy management, renewable energy, and resource conservation management fields by looking at some of the technology and performing calculations that are related to these industries.

The course will also define the need for energy management, renewable energy, and resource conservation management as an integral part of society at all levels. We will investigate the various professional opportunities in energy management, renewable energy, and resource conservation management through lectures and guest speakers.

REQUIRED TEXTS & MATERIALS

Plan B 4.0 Mobilizing to Save Civilization: Lester Brown

And One from the Following List:

The Power of Sustainable Thinking: Doppelt

Cradle to Cradle: McDonough and Braungart

Ecology of Commerce: Hawkin

Energy SoftPaths: A. Lovins

Natural Capitalism: A. Lovins, H. Lovins, Hawkin

(Or your suggestion)

GRADING POLICY:

Vocab Exam (2) 20%

Book Report (2) 20%

Personal Energy Use Project 30%

Informational Interview 30%

BRIEF CALENDAR OVERVIEW

Week Topic

- 1) Introductions. Course / Program Overview and Assignments
Why do Energy Efficiency and Renewable Energy. Amory
Lovins video.
- 2) How Buildings Consume Energy. Cradle to Cradle Design
Associated Energy Units / Calculations / Energy Utilization
Index.
- 3) Personal Home Energy Audit and Informational Interviewing.
Quiz 1, Guest Speaker Video, Local Guest Speaker
- 4) On-Line Energy Information, Professional Associations,
Newsletters Industry Publications. Video, Ray Anderson,
Interface Carpet.
- 5) Renewable Energy, Informational Interview, Local Guest
Speaker, Guest Speaker Video
- 6) 1st Vocabulary Quiz, Components of a Quality Energy
Management Program,
- 7) Energy Accounting, Informational Interviewing, Local Guest
Speaker, Guest Speaker video
- 8) 2nd Vocabulary Quiz, Benchmarking - EPA Portfolio Manager
- 9) All Assignments Due!
- 10) Building Consumption Trends
Building Demand Trends
- 11) Dec 8 Finals Week

Blue Print Reading

CREDIT: 3

This basic blueprint reading class will prepare you to read and evaluate drawings and specifications, do material take-offs and develop an in depth understanding of how buildings go together. We will explore construction methods of both residential and commercial structures. The class will primarily be lecture with the emphasis on participation. All work will be completed outside of class. Topics will be introduced and the student will perform exercises and reading as homework. All textbook exercise assignments are to be completed on Moodle prior to class.

REQUIRED TEXTS & MATERIALS:

Reading Architect Plans for Residential & Commercial Construction, by Ernest R. Weidhaas

Purchase the following materials and bring to class:

Architectural scale for drawing at $\frac{1}{4}'' = 1'-0''$

11' x 17" grid paper @ $\frac{1}{4}''$ (four squares per inch)

Triangle for drawing straight lines

You will need a calculator and a 25' tape measure

EXERCISES:

We will be doing a variety of exercises, all designed to bring your comprehension of the built environment more clearly into focus. Blueprint reading is a language, with it's own symbols, meanings, and interpretation. We will begin with the familiar and move slowly into the complex. As you complete each assignment, it is expected that you will save and compile the complete work in a journal-like format to be handed in at the end of the term. I find we learn best by doing, so my emphasis is going to be based around hands on practical applications, field examples, and creating working drawings of real projects.

GRADES:

Your final grade is composed of the weekly assignments (70%), the final group project (20%), and participation and attendance (10%). Please be clear that all grades are at my sole discretion and are not necessarily dependent upon points or accumulated exercises. I assess each persons performance upon my perception of what I feel they are capable of. Convince me, show your passion.

BRIEF CALENDAR OVERVIEW

Week Topic

- 1 Intro to course material, survey of student backgrounds.
Architectural symbols, techniques, conventions
 - 2 Review of building elements and components, connections,
and materials. Field trip for site measuring
 - 3 Framing plans, wall sections
 - 4 Units of measure, contours, site symbols, grading, utility
plans, terms, abbreviations. Foundation plans and details
 - 5 Unit calculations. Presentation of final Project format
 - 6 Commercial building
Reading, interpreting, and synthesizing information
 - 7 Window and door details. Schedules
 - 8 Structural steel
 - 9 HVAC, energy conservation. Introduce team projects
 - 10 Group presentations
- Finals Hand in work journals, exit review

Regular drawing assignments will be collected and evaluated to encourage consistent participation and to provide feedback on progress. ALWAYS hand in a photo copy of your work, never the original. Submit work that is of professional quality, well organized, concise and communicates effectively. Consider each assignment as a job interview, if you are late or don't have the goods, you don't get the job.

Sustainability and the Built Environment

CREDIT: 3

In this course, students will develop a basic understanding of sustainability, the “Three E’s” of sustainable development and how those concepts apply to the built environment. Students will be able to identify some of the environmental impacts that buildings have on air, water quality and land. They will also be able to identify the economic benefits of reduced operating costs, improvement of occupant productivity and optimization of life cycle economic performance. Students will also gain knowledge about the social benefits of a more sustainable built environment. Lastly students will gain knowledge about the Leadership in Energy and Environment Design (LEED) framework as well as other examples of creating a more sustainable built environment.

Required Text and Materials:

Philosophy of Sustainable Design - Jason McLennan - Ecotone Publishing, 2004

The Northwest Green Home Primer - Kathleen O’Brian - Timber Press Publishing, 2008

There is one required field trip during the term.

Grading Policy: Journal = 10% , Homework = 20%, Quizzes = 20%, Field Trip = 15%, Final Presentation of Student Project = 15%, Final Exam = 20%

BRIEF CALENDAR OVERVIEW

Week Topic

- 1A Introduction;
- 1B Sustainability & The Case for Green Building

- 2A What is LEED?;
- 2B Site Assessment

- 3A Land Use and Transportation;
- 3B Bio - Climatic Building & Passive Solar Design

- 4A Renewable Energy Options;
- 4B HVAC

- 5A Lighting;
- 5B Green Material Selection

- 6A Class Activity;
- 6B Indoor Environmental Quality

- 7A Commercial Water Use;
- 7B Residential and Outdoor Water Use

- 8A LCA - Life Cycle Analysis;
- 8B Alternative Buildings

- 9A Sustainable Job Site Operations &
- 9B Waste Stream; Operations and Maintenance

- 10 Final Presentations & Exam

- 11 FINALS WEEK

Alternative Energy Technology

CREDIT: 3

This course combines concepts, math, and Excel to study alternative methods of energy production, as well as current methods.

CLASS OBJECTIVES:

<ul style="list-style-type: none">• Survey and discuss conventional and alternative energy production technologies.• Develop awareness of current energy use patterns at local, regional, national and global levels.• Become familiar with standard physical units used for measuring energy and power.• Gain experience using Excel by completing two Excel based projects.	<ul style="list-style-type: none">• Identify the major site issues in determining the feasibility of solar, wind, hydro and geothermal energy sources.• Gain experience with basic calculations related to energy production.• Compare the advantages and disadvantages of various types of energy production, based on economic, environmental and social considerations.
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REQUIRED TEXTS & MATERIALS:

Handbook of Formulae, Equations, & Conversion Factors for the Energy Professional, (The Red Book) or any similar reference. No textbook, all materials available on moodle or as in-class handouts. Please bring a scientific calculator to each class. You will need access to Excel 2007 or newer (PC) or 2008 or newer (Mac) to complete the Excel projects.

GRADING POLICY:

10% Quizzes, 40% Homework, 10% Midterm, 10% Final,
15% Project 1, 15% Project 2

ASSIGNMENTS: Weekly homework will be assigned to help you practice basic energy calculations.

BRIEF CALENDAR OVERVIEW

Week 1 -- Intro, Energy Math, Oil

Week 2 -- Project 1, Coal, Natural Gas, Nuclear Power

Week 3 -- Heat Engines

Week 4 -- Biomass, Geothermal

Week 5 -- Solar, Project 2

Week 6 -- MIDTERM, Wave Energy

Week 7 -- Hydrogen, Wind

Week 8 -- Storage, Hydro

Week 9 -- Transportation

Week 10 -- Final Review

Residential/Light Commercial Energy Analysis

CREDIT: 3

Class is an introduction into residential and light commercial energy use. We will examine all the ways in which energy is utilized within a home or light commercial building and how by applying an understanding of building science we can determine measures that will reduce energy consumption and energy waste while maintaining the health, safety and comfort of the occupants. Topics include building envelope, insulation types, blower doors, indoor air quality, heat loss calculations, and building construction.

THE ASSESSMENTS FOR THE COURSE WILL CONSIST OF

Online quizzes that address the assigned readings

Online midterm and final exam

Projects that will require you to submit photo documentation

Submit small research assignments and excel spreadsheets

Demonstrated usage of a Blower Door and a Duct Blaster to measure air leakage

COURSE MATERIALS

A digital camera (can be your phone as long as you can download the images)

A calculator

Access to Microsoft Excel (or other) to produce simple spreadsheets

TEXT:

Residential Energy, John Krigger

GRADING POLICY:

Quizzes	20%
Projects	50%
Final	30%

BRIEF CALENDAR OVERVIEW

Week 1 -- Introduction/Overview Introduction, Principles of Energy
Chapter 1, Energy Transfer-Temperature, Humidity-Comfort-
Climate, Assessment

Week 2 -- Energy and the Building Shell Chapter 2, Building
Construction, Heat Flow through Shell, Thermal Boundary Defined,
Thermal Diagnostics, Heat Loss Calculations, Assessment

Week 3 -- Air Leakage Chapter 3, Air Pressure and Flow, Blower Door
testing, Duct Blaster testing, Duct Leakage, Construction Flaws/Air
Leakage, Air Sealing Methods

Week 4 -- Insulation Chapter 4, R-Values, Insulation Characteristics and
Types, Facings and Barriers, Retrofitting Insulation

Week 5 -- Midterm covering chapters 1-2-3-4, Heating Chapter 6
Combustion Process, Furnace Components, Combustion Safety,
Distribution System Types

Week 6 -- Cooling Chapter 8, Heat Gain, Humidity, Psychrometric
chart, Natural Cooling Methods, Mechanical Cooling, Air Conditioner
Efficiency and Sizing

Week 7 -- Water Heating Chapter 9, Water Heater Energy Use, Water
Heater Components, Combustion Safety, Water Heater Efficiency

Week 8A -- Windows and Doors Chapter 5, Window Labels, Air
Leakage, Improvements in windows, Door Types and Thermal Values

Week 8B -- Lighting and Appliances Chapter 7, Lighting Efficacy, Color
Rendering, Lighting Types, Appliances and Efficiency

Week 9 -- Health and Safety Chapter 10, Indoor Pollutants, Moisture
Control, Mechanical Ventilation, Air Conditioners and Dehumidifiers

Week 10 -- Review, Projects completed

Final Exam Covering Chapters 5-6-7-8-9-10

Air Conditioning Systems Analysis

CREDIT: 3

This is an introductory course on heating, ventilation and air conditioning systems. This course covers the fundamental theoretical principals and practical descriptions of the various HVAC equipment and systems used in commercial buildings.

The student will learn basic thermodynamics and heat transfer. In this course we will cover heating and cooling load calculations, develop an understanding of psychrometrics and air/water properties. This course will introduce the student to various types of HVAC equipment, analyze efficiencies of equipment and systems and learn how to estimate annual energy use of buildings.

GRADING POLICY:

3 Exams each worth 20% of total grade

Project #1 10%

Project #2 10%

Homework 15%

Homework assignments are for the benefit of the student to gain further knowledge of the course curriculum and as preparation for the exams. Homework will be assigned on a weekly basis with the solutions posted the following week. Two projects will be assigned during the term and will be due as noted.

EXAMS:

There will be 3 exams. These will be relative to the class assignments and appear very much like many of the homework examples.

Success in this class will depend on class attendance/viewing lectures and completing the homework assignments. The exact dates for the exams will be presented in class.

TEXT:

Air Conditioning Principals and Systems "An Energy Approach"
By Edward G. Pita

Principals of HVAC, 6 th Edition * based on the 2009 ASHRAE Handbook of Fundamentals *Suggested supplement, but not required.

BRIEF CALENDAR OVERVIEW

Week 1 -- Introduction to course, physical properties of substances, units and unit conversions, pressure.

Week 2 -- Work, power and energy, temperature and enthalpy, sensible and latent heat.

Week 3 -- Heat transfer, estimating building component "R" values and "U" values, heat loss calculations for commercial building applications.

Week 4 -- EXAM #1 Warm air furnaces and boilers.

Week 5 -- Hydronic systems

Week 6 -- The cooling load for commercial buildings.

Week 7 -- Psychrometrics

Week 8 -- EXAM#2

Vapor compression refrigeration systems and heat pumps

Week 9 -- Degree Day analysis and energy use, commercial air conditioning systems, efficiencies

Week 10 -- Review

Finals Week

EXAM #3

Energy Efficient Methods

CREDIT: 4

A systems approach is used to analyze the input, output, and efficiency of commonplace energy conversion devices. Included are motors, fans, pumps, heat engines, domestic hot water heaters, furnaces, boilers, refrigeration devices, and heat pumps. In so doing students (1) become fluent in the use of the many different units used to denote and measure energy/power (2) learn what quantities need to be measured to determine energy/power in different systems (3) determine the energy/cost savings associated with different efficiency improvement strategies.

CLASS OBJECTIVES:

<ul style="list-style-type: none"> • Use significant figures and an appropriate level of accuracy when manipulating and expressing numerical data • Use the energy/power equations & appropriate units to do efficiency calculations in the 4 primary energy systems: mechanical, fluid, electrical, thermal. 	<ul style="list-style-type: none"> • Understand electrical production, transmission, and distribution systems • Understand the following electrical phenomena: AC vs. DC power sources, single & three phase power, power factor • Understand right triangle trig functions used in energy systems calculations • Use the ratio method for converting units used in energy/power calculations
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TEXTS & MATERIALS:

Physics in Context: An Integrated Approach (Optional)

PRE AND CO-REQUISITES

Math 65 or equivalent (Pre-requisite) Excel Spreadsheets (Co-requisite)

GRADING POLICY:

40% Homework, 15% Excel, 15% Midterm 1, 15% Midterm 2, 15% Final

TEACHING METHODS:

Lecture-discussion, math labs, small group discussion, power point presentations, demonstrations, computer labs, and practice (no grade) tests.

BRIEF CALENDAR OVERVIEW

Week Topic

- 1 Overview: SI & English system of measurement:
Converting Units
Scientific notation, Significant figures: Accuracy & precision
- 2 Right triangle trig: Lab- Sine and cosine function
Interpolation and extrapolation of data from tables
- 3 Midterm: Unit 1
Mechanical systems basics:
Linear and rotational mechanical power
- 4 Rotational kinetic energy:
Flywheels: Mechanical power working equations
Motors, motor slip, and load factor: Lab - Mechanical Power
- 5 Fluid systems basics: Fluid power working equations
Fan Tables: Fan laws
- 6 Electrical systems basics:
Electrical power working equations-resistive loads
Ohms law: Electrical power laws:
- 7 Electromagnetic Induction:
Three phase power: Reactance: Power Factor:
Electrical power working equations-reactive and 3 phase loads
- 8 Midterm Exam: Unit 2 only
Thermal systems Basics: Thermal working equations
- 9 1st law of Thermodynamics: Heat engines: Heat of Combustion
- 10 Furnace, domestic hot water, and boiler efficiency
Efficiency of air conditioners and heat pumps

Lighting Fundamentals

CREDIT: 3

The course consists of lectures, reading assignments from the text, complementary material from class handouts, quizzes, exams and assigned homework. Students are expected to play an active part in the course and in covering its content.

<ul style="list-style-type: none"> * Understand the terminology that is used in the lighting industry. * Identify and evaluate the various quantitative and qualitative characteristics of light sources. * Identify and evaluate the various characteristics and components of luminaries. * Use accepted methods for assessing illumination levels and lighting quality metrics. 	<ul style="list-style-type: none"> * Assess various lighting related strategies for achieving an energy efficient and effective luminous environment. * Understand basic lighting control strategies. * Assess and analyze energy and cost savings associated with various lighting measures. * Develop an awareness for lighting applications, approaches and strategies. * Become familiar with federal and state legislation related to lighting.
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OPTIONAL TEXT: Advanced Lighting Guidelines – 2003 Edition (www.newbuildings.org) a read-only PDF is supplied.

SUPPLEMENTAL MATERIAL: Course Handouts

COURSE MATERIALS

A digital camera (can be your phone as long as you can download the images)

GRADING POLICY:

Late work will not be accepted, except in the case of an excused absence or if arrangements have been made in advance.

Lecture / Lessons 30%, Activities 30%, Final Presentation 10%, Exams - 2 total. each worth 15%. (BIG Hint: most of content for exams are pulled directly from the lessons)

BRIEF CALENDAR OVERVIEW

Week	Topic
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- | | |
|----|--|
| 1 | Introduction; History; Vision |
| 2 | Human Considerations; Light Characteristics |
| 3 | Lighting Metrics; Light Sources |
| 4 | Light Sources |
| 5 | Light Sources |
| 6 | Light Sources |
| 7 | Light Sources |
| 8 | Luminaires & Light Distribution |
| 9 | Lighting Controls |
| 10 | Calculations / Efficiency Strategies / Economics |
| 11 | Final Exam |

Commercial Air Conditioning Systems Analysis

CREDIT: 3

Students completing this course will be able to identify commercial HVAC system types and the general energy impact of each type. Students will investigate HVAC delivery systems that will include fans pumps dampers, control valves, and ducting.

The Class consists of several lectures and supporting examples worked out. The solutions for each week will be available the following week.

REQUIRED TEXT: Air Conditioning Principles & Systems, by Edward G. Pita, 4th Edition

GRADING POLICY:

Exams (3 each worth 10%)	30%
Weekly Assignments	50%
Lectures	10%
Participation	10%

BRIEF OVERVIEW

Lecture 1.1 - Review of fundamentals, units, properties, pressure, work, power and energy

Lecture 1.2 - Demand v. Energy Use, sensible heat equation, review of heating and cooling loads

Lecture 2.1 - Air conditioning systems – classification types. Reheat, Multi-zone, Dual duct, VAV, Equipment types and I.A.Q

Lecture 2.2 - Psychrometrics review, process lines on the psychrometric chart, evaporative cooling and the mixed air process.

Lecture 3.1 - Datalogging – Introduction, applications, calculations.

Retrieving and using data from AHU-1 and MZ-8

Lecture 3.2 - Datalogging applications, cont.

Week 4 EXAM #1

Lecture 4.1 - Vapor Compression Refrigeration; Compressors

Lecture 4.2 - Evaporators, Condensers, Cooling Towers and Expansion Devices

Lecture 5.1 - Refrigeration system types, Energy Balance in refrigeration systems, Heat Pumps

Lecture 5.2 - Commercial applications of heat pumps, water source heat pumps, energy efficiency of heat pump systems and fundamentals of heat exchangers.

Lecture 6.1 - Fluid flow in piping and ducts, continuity principle

Lecture 6.2 - Bernoulli's Principle

Week 7 EXAM #2

Lecture 7.1 - Static pressure, velocity pressure, total pressure, manometers and pitot tubes

GUEST SPEAKER 7.2 - Steve Farnes from Cole Industries presentation on boilers

Lecture 8.1 - Fans, fan tables, fan curves and fan laws

Lecture 9.1 - Pumps, pump curves, pump affinity laws

Lecture 10.1 - Pump affinity laws and energy savings calculations for pumps

Tour and video of Central Plant

Week 11 (Finals week)

Lighting Applications

CREDIT: 3

The course consists of lectures, reading assignments from the text, complementary material from class handouts, mini-projects, field trips, and a final project. Students are expected to play an active part in the course and in covering its content.

The areas following will be emphasized:

Lighting metrics and source review

Advanced sources and luminaires

Applied Calculations

Energy and building codes

Formulate objectives and develop an understanding of lighting applications issues and concerns

TEXT:

The following three textbooks from the Electric Power Research Institute and the Advanced Lighting Guidelines 2003 will be used throughout the class. The first is the required textbook and the other two EPRI documents are for supplemental reading. In addition to these EPRI resources, we will also be using the Advanced Lighting Guidelines 2003, which was also used for the Lighting Fundamentals class.

PREREQUISITES:

Lighting Fundamentals or consent of instructor.

GRADING POLICY

Photos of the week	25%
System Comp. spreadsheet	5%
Homework	35%
Field Work	10%
Final Project	25%

BRIEF OVERVIEW

Introduction to Lighting Applications, Course Outline

Review material to bring from last term

Discuss report so students understand the end result

Overview of Lighting Upgrade. What steps are involved in going from concept to construction

Tools: Forms, light meter, flicker checker, ballast inspection, digital camera. Field work and data collection

System Efficacy: Lamps and Ballasts. Concentrate on Lin Fluor. Reading Lamp and Ballast cutsheets

Source and Fixture Changes: MH to LF, Inc to LF, Inc to LED. Reading Fixture Cutsheets

Occupancy Sensors PIR, US, DT, control Strategies (Distributed and Central)

Daylighting Control Equipment: Distributed and Central. On/Off and Dimming

Baseline - Proposed = Energy Savings

HVAC Interaction, Maintenance Savings, System Compare Point-by-Point Method, Lumen Method (Zonal Cavity Calculation)

Visual Software

Measure Cost Estimating, Incentives (BPA, ETO, BETC), Simple Payback, melded kwh cost and demand/consumption cost

Schools and Other Public Buildings

Offices, Retail, Warehouses

Lab Day, work on Final Report

Audit, Design, Bidding, Methods of Implementing Construction. Use ODOE case studies.

Energy Investment Analysis

CREDIT: 3

Topics include: interest, simple payback and life-cycle cost analysis, time value of money, cash flow equivalence, cost-benefit analysis, effects of tax credits, depreciation, inflation and/or escalating fuel costs on energy investments, and cost estimating procedures. The emphasis will be on analysis of energy investments using spreadsheets to consider total cost-benefits over the life of the investment.

OBJECTIVES

- Estimate costs and benefits of various energy projects.
- Calculate energy cost and cost savings of energy investment alternatives, using utility rate schedules.
- Perform simple payback analysis of proposed energy investment alternatives.
- Perform life cycle cost analysis of proposed energy investment alternatives.
- Solve economic analysis problems involving the time value of money, inflation, and escalating cost of energy.
- Perform manual and computerized economic analysis of energy investment alternatives.
- Prepare a written report of an independent energy investment analysis project.

GRADING POLICY

Homework	40%
Midterm	10%
Final	10%
Project	40%

PROJECT: A report consisting of a life-cycle cost analysis (LCCA) with supporting spreadsheets. More details given in class.

You will need access to Excel 2003 or higher and a word processor such as Word to complete the project.

BRIEF CALENDAR OVERVIEW

Week Topic

- 1 Introductions, Course Overview, Requirements, and Text Review unit conversions and basic algebra; handle large numbers effectively in presentations and calculations; define terms relating to energy units
- 2 Conceptual introduction to Life Cycle Cost analysis and to calculations used in economic analysis of energy projects, Read Chapter 1 of NIST 135 Documentation and defining the investment decision, Read Chapter 2 of NIST 135
- 3 Calculate time equivalent values to adjust for inflation and lost investment opportunities, Read Chapter 3 of NIST 135 Cost Estimating, Current and Future Dollar Values, Read Chapter 4 of NIST 135
- 4 Energy costs
Mid-Term Review
- 5 MID-TERM EXAM.
Life Cycle Cost Analysis (LCCA), Read Chapter 5 of NIST 135
- 6 Life Cycle Cost Analysis (LCCA)/DRAFT PROJECT STATEMENT DUE
Supplementary Measures: Net Savings (NS), Savings to Investment Ratio (SIR), Read Chapter 6 of NIST 135
- 7 Software to perform LCCA and other economic measures
Read handout on Equest LCC capabilities.
Determine the appropriate economic analysis method for different project types, Read Chapter 7 of NIST 135
- 8 Risk and Uncertainty in LCCA, Read Chapter 8 of NIST 135
Sensitivity Analysis
- 9 Workday
- 10 Program Management Cost Effectiveness Tests, LCCA
PROJECT DUE

FINAL EXAM

Commercial Energy Use Analysis

CREDIT: 4

COURSE OBJECTIVES:

<ul style="list-style-type: none"> • Provide exposure to the entire energy analysis process with a "hands-on" implementation of an actual building energy study. • Distinguish between different activities involved in a comprehensive energy analysis effort, i.e., plan review, walk-through, identification of Energy Conservation Measures (ECMs), cost estimating, energy savings calculations and report writing. • Understand the preparation requirements for doing a commercial building energy analysis. • Use appropriate energy audit forms and develop good record keeping habits. • Understand, recognize, and describe major energy using systems found in typical commercial buildings. 	<ul style="list-style-type: none"> • Use common auditing and field measurement instruments during actual audit including light meter, ammeter, and digital data logging instruments. • Become familiar with a broad range of energy conservation measure technologies. • Prepare cost estimates for at least one energy conservation measure. Become familiar with good cost estimating techniques for energy conservation measures. • Calculate savings for at least one energy conservation measure. Distinguish between the commonly used methods for computing energy savings for energy conservation measure including manual methods (hours of operation and connected load), variable degree-day calculations, bin methods and hourly simulations.
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GRADING POLICY:

Class Assignments:	60%
In-Class/Labs	10%
Subjective Evaluation:	10%
Final Exam/Project:	20%

BRIEF CALENDAR OVERVIEW

Week 1 - Introduction to course, energy use in commercial buildings, degree day and bin data, EUI, energy bills, end use.

Week 2 - Spreadsheet calculations, plan for energy audit, notebook development, energy savings calculations

Week 3 - Building 16 – review plans, prepare and conduct walk-through of building, possible ECMs for Building 16

Week 4 - Lighting systems ECMs, Data logging applications

Week 5 - HVAC Systems surveys, process loads and ECMs, data logging applications

Week 6 - Finalize field work, retrieve data loggers / Midterm Exam

Week 7 - Analyze results, develop ECMs and calculations for ECMs. Technical report development basics

Week 8 - Continue work on Final Project –ECM calculations

Week 9
Continue work on Final Project

Week 10 - Continue work on Final Project

Final - Team Presentations and Final Project Reports due

Energy Control Strategies

CREDIT: 4

This course serves as an introduction to basic control theory as it relates to building HVAC systems. Integration of various HVAC concepts and control systems facilitates the completion of an energy savings calculation project.

Objectives:

- Learn basic control theory
- See how various HVAC components fit together in a system
- Study the most common control strategies used in HVAC
- Analyze how control sequences affect energy savings

REQUIRED TEXTS & MATERIALS:

Fundamentals of HVAC Control Systems (IP Edition),
Montgomery & McDowall, ISBN 978-0-08-055233-0
Miscellaneous handout material provided by instructor.

PROJECT:

Model a complete HVAC system and analyze ECMs from a controls perspective. Individual project. Excel and written report required. More details given in class.

GRADING POLICY:

Homework	40%
Midterm	10%
Final	10%
Project	40%

BRIEF OVERVIEW

presented in each of the three segments:

Binary control with electric elements. Covers on/off controls typically used for unitary commercial equipment and introduces more advanced electric control strategies for central plants. Electric controls provide a working example of binary controls.

- * Introduction, overview, and class expectations.
- * Open & closed control loops and basic control theory.
- * Control actions and modes and basic control logic.
- * Process, block, & electric diagrams and symbols.
- * Differential control, simple & programmable thermostats.
- * Staged control, electric control circuits, relays, and control logic.
- * Time clocks, control purpose, and equivalent full load savings.

Control Systems I. Introduces modulating control elements using pneumatic controls as a working example.

- * Sequence of operations and ladder logic diagrams.
- * Ladder & Block Diagrams for a Smart Relay (Programmable Logic Controller or PLC)
- * Modulation and proportional controllers and controller action.
- * Flow control devices (valves and dampers) and actuator control ranges.
- * Device & controller action, algebraic analysis of controller output.
- * Advanced sequence of operations, control device sequencing.
- * Outside air economizer savings.

Control Systems II. Introduces energy control issues for more sophisticated HVAC systems and overviews direct digital control approaches.

- * Resets, coordination, and other advanced control strategies.
- * Control strategies for single-zone, multi-zone, and VAV systems.
- * Control tuning, maintenance, and commissioning.
- * Supervisory control (EMCS) and DDC block programming.

Building Energy Simulations

CREDIT: 4

This course is organized into two parts: (1) an energy simulation primer (first 5 weeks) and (2) an applied energy modeling project using an actual building (second 5 weeks). The primer will emphasize group labs while in class supported by related homework assignments designed to allow students to explore the various features and capabilities of the energy simulation software used in this course.

Class Objectives

1. Gain direct, hands-on experience with Equest / DOE2.2 – an hourly energy modeling tool that represents one of the more widely used tools in the United States.
2. Expand knowledge of the contributing factors to heating and cooling loads in commercial buildings.
3. Enhance understanding of secondary HVAC systems via DOE2 simulation.
4. Understand the steps involved in energy simulation of commercial buildings – zoning, baseline modeling development, calibration of baseline model, and modeling of energy efficiency measures.
5. Provide exposure to the entire energy analysis process with a “hands-on” implementation of an actual building energy study through cooperative interaction with Energy Accounting class and use of information collected during the Commercial Energy Analysis class (winter term).

REQUIRED TEXTS & MATERIALS:

Building Energy Simulation Guidelines Packet EQUEST Software (provided on CD by instructor) DOE2.2.

Documentation (provided on CD by instructor), Various hand-outs (by instructor) Architect's Scale Engineer's Scale

GRADING: Exam: 15%, Lessons: 15% Class Labs: 20%, Class Project & Presentation: 35%, Subjective Evaluation: 10% Active Participation: 5%

WEEKLY OVERVIEW

Week 1, Class 1 - Why Buildings Use Energy Other: Review of the Course Outline and Expectations Lab (group): Tour Equest via building creation wizard to create a simple building model Reading: Building Simulation Guidelines, Part 1

Week 1, Class 2 - An Overview of Performance Modeling Lab (group/individual): Extract and process local weather data Reading: TMY2/TMY3 Manuals

Week 2, Class 3 - Thermal Zoning / Defining Geometry the Hard Way Lab: (group) Use Equest building creation wizard to input geometry and thermal zones. Reading: DOE2.2 Manual, selected sections

Week 2, Class 4

Lecture: None Lab (group/individual): Energy Assessment of the New Science/Math Building. Interactive Brainstorming of Energy Use Reduction Opportunities / Assign Class Project Assignments Walk-through

Week 3, Class 5 - Input of Envelope Construction and Glass Types Lab (group): Develop sections of dominant Math Science constructions and define in Equest.

Week 3, Class 6 - Internal Loads - People, Lights, and Equipment Lab (group/individual): Internal Loads Modeling: Refine peak internal loads inputs and schedules; Run and review/print LS-C, LS-E, and LS-B reports.

Week 4, Class 7 - Other Load Inputs - Thermal Mass, Daylighting Controls, Window Management Lab (group): Review/refine input of internal mass, daylighting, and shading; as well as any other load-related inputs; request hourly reports on selected windows to study solar gain (delayed and instantaneous). Two runs with different internal mass and/or shading elements.

Week 4, Class 8 - Lab (group/individual): Break up into audit teams and conduct internal loads surveys – lighting, equipment, and people; translate directly to modeling input for sharing with entire class. Walk-through

Week 5, Class 9 - HVAC: Defining the Thermal Zone: Temperature Control, Ventilation, and Thermal Zones (Terminal Units) Lab (group): Input and Modeling of Variable Air Volume Systems

Week 5, Class 10 - HVAC: Common and Uncommon VAV System Lab (group/individual): Exploring the Energy Dynamics of Reheat. As a group we will complete the HVAC input (system and plant). Individually, modifications will be made to supply air temperature input and minimum air flow rate inputs to document the changes to heating energy use. Midterm Exam

Week 6, Class 11 - HVAC: Hydronic Loops & Pumping Systems Lab (group): HVAC: Modeling Hydronic Systems; Complete input of hydronic loops and pumping systems for the Science Building model.

Week 6, Class 12 - Lab: Datalogging installation of variable air volume terminal units. Walk-through: Data-logging of HVAC terminal units / Possible follow-up tour of LCC plant.

Week 7, Class 13 - HVAC: Chillers and Boilers Lab (group): HVAC: Modeling Chiller and

Boiler Plants: Input a mini-version of the LCC central plant.

Week 7, Class 14 - HVAC: Alternate HVAC Systems: De-coupled Systems Lab (group/individual): Modeling De-coupled HVAC Systems. As a group we will input a non-explicit de-coupled system with dedicated OSA, heat recovery, and zonal heating/cooling. As individuals, hourly reports will be extracted and analyzed to determine the validity of the model results.

Week 8, Class 15 - HVAC: Packaged Systems: PSZs, PVAVs, & PTACs Lab (group): Modeling Packaged Single Zones: Defining Efficiencies and Fans; Economizers

Week 8, Class 16 - Lab: Comprehensive Review of Datalogging and HVAC Field Data; Review of ECM/O&M Modeling Approaches. Walk-through (as needed)

Week 9, Class 17 - Calibrating Baseline Models for Existing Buildings Lab (group): Review model outputs and compare to datalogging results and other knowledge of existing building performance; Make changes as applicable to model input.

Week 9, Class 18 - Baseline Models for New Buildings: Navigating Energy Codes (Oregon and ASHRAE 90.1) Lab (individual): Review model outputs and compare to datalogging results and other knowledge of existing building performance; Make changes as applicable to model input.

Week 10, Class 19 - Modeling ECMs and O&Ms Lab (individual): Make input changes for modeling of ECM or O&M. Each student will be working individually with two models – baseline and proposed improvement.

Week 10, Class 20 - Project Focus: Modeling ECMs and O&Ms Lab (individual): Make input changes for modeling of ECM or O&M. Each student will be working individually with two models – baseline and proposed improvement.

Week 11, Final - Brief Project Summaries (oral); Hand-in Final Report

notes:

Energy Accounting

CREDIT: 3

The purpose of this course is to enable the students to set up and use an Energy Accounting system. The class will review basic energy units needed for Energy Accounting and will cover the concepts of adjusted baseline, rate schedules, load factor, load shape, and base load. The student will learn methods for analyzing and presenting utility data including Utility Cost Management, Operation and Maintenance Improvements, Capital Improvement Measures (ECMs), Measurement and Verification to Confirm Savings and Monitoring Systems to Maintain Cost Reduction.

TEXT

Peter Herzog, *Energy Efficient Operation of Commercial Buildings*.

GRADING:

Reading Quizzes	40%
Homework	20%
Final Exam	20%
Lectures	10%
Subjective Eval.	10%

BRIEF CALENDAR OVERVIEW

Energy Accounting (4 weeks)
Resource Conservation Management (1 week)
Operation and Maintenance (3 weeks)
Measurement and Verification (2 weeks)

Finals Week

Cooperative Education

CREDIT: 6

Students are expected to spend a minimum of 108 hours (3 credits) per term working and learning Energy Management skills and techniques such as data collection, processing and analysis, documentation, software applications, product research, lighting and HVAC analysis, blueprint reading, customer relations, energy auditing, and estimating.

Placements are usually off campus and can be any time during the term but usually not in the last three or four weeks. Employers understand that the student is a student and not a polished Energy Management Technician. The course may be repeated for additional credits. It is extremely important for the student to make early contact with the coordinator regarding the placement or any problems (or potential problems) with a placement.

COURSE OBJECTIVES:

1. To provide opportunities for students to apply classroom based theoretical knowledge to solving real-world problems.
2. To introduce students to knowledge, skills, methods, procedures and practices that supplement and enhance those already learned in the classroom.
3. To help students develop work place based learning skills through the development of learning objectives.
4. To allow students to assess suitability and preparedness for their career choice.
5. To provide practical experience for future employment.
6. To provide opportunities to network with potential employers.

Credit: Students earn one college credit for every 36 hours worked in a term. Students are expected to enroll for 3 or more credits per term and must seek instructor's permission if they wish to enroll for fewer than 3 credits. **Retroactive credits are not available.**

GRADING:

The grade for the work term is based upon 1) the employer's written evaluation of the student's performance 2) a work site visit by the cooperative education coordinator 3) weekly reports of the work experience provided by the student 4) a written self evaluation of the work experience by the student. These all must be completed by the end of the term to qualify for a grade.

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