Course Number and Title: NRG 226 Building Mechanical/Electrical Systems Analysis

Campus Location:
Georgetown, Dover, Stanton

Effective Date:
2018-51

Prerequisite:
NRG 126

Co-Requisites:
none

Course Credits and Hours:
4.00 credits
3.00 lecture hours/week
2.00 lab hours/week

Course Description:
This course covers the physics and calculations used in energy analyses, including thermodynamics, fluid flow mechanics, power factor, motor operation, and single- and three-phase power calculations. Topics include interpolation and extrapolation methodology used in energy calculations, weather data manipulations, and energy use analysis. Lab activities include data logging and analyzing building HVAC and/or electrical systems.

Required Text(s):
Obtain current textbook information by viewing the campus bookstore - https://www.dtcc.edu/bookstores online or visit a campus bookstore. Check your course schedule for the course number and section.

Additional Materials:
Scientific calculator (preferably TI-83 or TI-84+), Notebook

Schedule Type:
Classroom Course

Disclaimer:
None

Core Course Performance Objectives (CCPOs):

1. Engage in professional behavior. (CCC 1, 3, 4, 5)
2. Solve energy efficiency problems to include interpolation, right triangle functions, appropriate use of significant figures, and factor label method. (CCC 2, 6; PGC BAS 3, 4; NRG 3, 4, 5, 6)
3. Employ the basic electrical concepts and equations needed for energy efficiency calculations.
4. (CCC 2, 6; PGC BAS 1, 2 NRG 1, 2, 3, 4, 5)
5. Employ energy and power equations and appropriate units to solve efficiency calculations for the four major energy systems: mechanical, fluid, electrical, and thermal. (CCC 2, 6; PGC BAS 1, 2, 3; NRG 2, 3)
6. Use thermodynamics, heat transfer, and fluid flow dynamics to analyze HVAC commercial system and component performance. (CCC 2, 6; PGC BAS 2, 3; NRG 2, 3, 5)
7. Recommend system improvements based on predicted performance, and calculate energy and cost savings. (CCC 1, 2, 5, 6; PGC BAS 3; NRG 3, 5, 6)

See Core Curriculum Competencies and Program Graduate Competencies at the end of the syllabus. CCPOs are linked to every competency they develop.

Measurable Performance Objectives (MPOs):
Upon completion of this course, the student will:

1. Engage in professional behavior.
    1. Demonstrate punctuality when attending class, participating in off-site projects, and submitting assignments.
    2. Communicate using industry-appropriate language during presentations, reports, and homework.
    3. Demonstrate appropriate professional behavior when working with others.
2. Solve energy efficiency problems to include interpolation, right triangle functions, appropriate use of significant figures, and factor label method.
    1. Defend a value obtained for an energy efficiency calculation using interpolation or extrapolation by hand and with a spreadsheet program.
    2. Use the appropriate level of accuracy when manipulating and expressing numerical data.
    3. Differentiate among the right triangle trigonometric functions, and demonstrate their use in energy efficiency problems.
    4. Use factor label method (also called dimensional analysis or ratio method) for unit conversion.
3. Employ the basic electrical concepts and equations needed for energy efficiency calculations.
    1. Explain the skills and workplace habits to ensure safe work practices.
    2. Define *current*, *voltage*, *energy*, and *power*, and identify their units of measure.
    3. Use Ohm's law to calculate resistance, voltage, or current.
    4. Apply Ohm's law and the power equation to determine unknown quantities.
    5. Calculate electrical values such as total voltage; voltage drops; current; resistance; and power dissipation of series, parallel, and series-parallel circuits.
    6. Use test equipment to measure the voltage, current, and resistance of a circuit.
    7. Identify a sinusoidal waveform, and measure its characteristics.
    8. Explain the principles of a magnetic field.
    9. Compute the value of impedance in an AC circuit.
    10. Describe the construction and operation of a typical transformer.
    11. Perform voltage and current calculations for step-up and step-down transformers.
    12. Explain how motors convert electrical energy into rotational motion.
    13. Identify and explain the operation of various DC and AC motors.
4. Employ energy and power equations and appropriate units to solve efficiency calculations for the four major energy systems: mechanical, fluid, electrical and thermal.
    1. Compare linear and rotational mechanical power.
    2. Analyze the mechanical power working equations and how they relate to motors.
    3. Analyze how motor load factor is calculated and how it is related to motor efficiency.
    4. Determine the load factor of a working motor.
    5. Describe the operation of motors, fans, and pumps.
    6. Examine the fluid power working equations and how they apply to fans and pumps.
    7. Employ fan tables and fan laws to calculate fan efficiency.
    8. Differentiate among electric horsepower, brake horsepower, and air horsepower.
    9. Apply the conservation laws (momentum, mass, and energy) to fluid flow problems.
    10. Using Bernoulli's equation, calculate changes in fluid flow velocity due to area difference.
    11. Calculate the frictional losses imparted on fluid flow due to piping and duct size and arrangements.
    12. Employ Ohm's law and the electric power equation to solve energy efficiency problems.
5. Use thermodynamics, heat transfer, and fluid flow dynamics to analyze HVAC commercial system and component performance.
    1. Use psychrometrics to analyze air handler performance by calculating percentage of ventilation air.
    2. Determine coil performance by analyzing discharge air temperature data.
    3. Analyze fan performance data, and calculate energy consumption and operating cost.
    4. Analyze pump performance to determine efficiency improvement strategies.
    5. Identify data loggers and components model and serial numbers.
    6. Develop and maintain records to track deployment.
    7. Access and use the software program necessary for device configuration and deployment.
    8. Select and configure appropriate devices for each application.
    9. Safely deploy devices in appropriate locations to track system performance.
    10. Use the hardware and software necessary to download data.
6. Recommend system improvements based on predicted performance, and calculate energy and cost savings.
    1. Recognize methods to measure equipment efficiency, including annual fuel utilization efficiency (AFUE), energy factor (EF), co-efficient of performance (COP), energy efficiency ratio (EER), seasonal energy efficiency ratio (SEER), and heating season performance factor (HSPF).
    2. Predict energy saving potential for different air handler operational changes such as occupancy and ventilation air adjustments.
    3. Analyze various component and system airflow changes for energy reduction and calculate potential cost savings.
    4. Analyze different hydronic system and component operational change for energy reduction and potential cost savings.
    5. Prepare a report to make recommendations for a HVAC system improvement, supported by calculated energy and cost savings.

Evaluation Criteria/Policies:
Students must demonstrate proficiency on all CCPOs at a minimal 75 percent level to successfully complete the course. The grade will be determined using the Delaware Tech grading system:

92	–	100	=	A
83	–	91	=	B
75	–	82	=	C
0	–	74	=	F

Students should refer to the Student Handbook - https://www.dtcc.edu/handbook for information on the Academic Standing Policy, the Academic Integrity Policy, Student Rights and Responsibilities, and other policies relevant to their academic progress.

Core Curriculum Competencies (CCCs are the competencies every graduate will develop):

1. Apply clear and effective communication skills.
2. Use critical thinking to solve problems.
3. Collaborate to achieve a common goal.
4. Demonstrate professional and ethical conduct.
5. Use information literacy for effective vocational and/or academic research.
6. Apply quantitative reasoning and/or scientific inquiry to solve practical problems.

Program Graduate Competencies (PGCs are the competencies every graduate will develop specific to his or her major):
Building Automation Systems

1. Utilize building system and energy technology hardware and software to gather data on building lighting systems operation and energy consumption.
2. Utilize building system and energy technology hardware and software to gather data on heating,
3. Evaluate commercial buildings and make recommendations for optimized building performance and occupant comfort.
4. Prepare and present technical reports.
5. Assemble, install, service, and repair direct digital controls (DDC) for building electrical and mechanical systems.
6. Program and explain operational sequences for building equipment and systems.
7. Integrate and commission building systems and components to ensure reliable performance and compliance with building codes.

Energy Management

1. Utilize building system and energy technology hardware and software to gather data on building lighting systems operation and energy consumption.
2. Utilize building system and energy technology hardware and software to gather data on heating, ventilation, and air conditioning (HVAC) systems operation and energy consumption.
3. Calculate, analyze, and verify the energy use of buildings based upon the interaction of energy consuming building systems.
4. Evaluate residential buildings and make recommendations for optimized building performance and occupant comfort.
5. Evaluate commercial buildings and make recommendations for optimized building performance and occupant comfort.
6. Prepare and present technical reports.
7. Analyze the economic, environmental, and business implications of potential energy measures.

Disabilities Support Statement:
The College is committed to providing reasonable accommodations for students with disabilities. Students are encouraged to schedule an appointment with the campus Disabilities Support Counselor to request an accommodation needed due to a disability. A listing of campus Disabilities Support Counselors and contact information can be found at the disabilities services - https://www.dtcc.edu/disabilitysupport web page or visit the campus Advising Center.