#44854

Office of the Registrar
FORM 40G REV. 10/10

PURDUE UNIVERSITY

REQUEST FOR ADDITION, EXPIRATION, OR REVISION OF A GRADUATE COURSE
(50000-60000 LEVEL)

Graduate Council Doc. 12-3c
EID 18-12

DEPARTMENT Civil Engineering

EFFECTIVE SESSION Fall 2012 (201310)

INSTRUCTIONS: Please check the items below which describe the purpose of this request.

- [X] 1. New course with supporting documents (complete proposal form)
- [ ] 2. Add existing course offered at another campus
- [ ] 3. Expiration of a course
- [ ] 4. Change in course number
- [ ] 5. Change in course title
- [ ] 6. Change in course credit/type
- [ ] 7. Change in course attributes
- [ ] 8. Change in instructional hours
- [ ] 9. Change in course description
- [ ] 10. Change in course requisites
- [ ] 11. Change in semesters offered
- [ ] 12. Transfer from one department to another

PROPOSED:	EXISTING:
Subject Abbreviation CE	Subject Abbreviation
Course Number ~~51500~~ 51501	Course Number
Long Title Building Energy Audits	
Short Title Building Energy Audits	

Abbreviated title will be entered by the Office of the Registrar if omitted. (30 CHARACTERS ONLY)

TERMS OFFERED
Check All That Apply:
[X] Fall [X] Spring [ ] Summer

CAMPUS(ES) INVOLVED
[ ] Calumet [ ] N. Central
[ ] Cont Ed [ ] Tech Statewide
[ ] Ft. Wayne [X] W. Lafayette
[ ] Indianapolis

CREDIT TYPE
1. Fixed Credit: Cr. Hrs. 3
2. Variable Credit Range: Minimum Cr. Hrs ____ (Check One) To [ ] Or [ ]
Maximum Cr. Hrs. ____
3. Equivalent Credit: Yes [ ] No [X]
4. Thesis Credit: Yes [ ] No [X]

COURSE ATTRIBUTES: Check All That Apply
1. Pass/Not Pass Only [ ]
2. Satisfactory/Unsatisfactory Only [ ]
3. Repeatable [ ]
Maximum Repeatable Credit: [ ]
4. Credit by Examination [ ]
5. Special Fees [ ]
6. Registration Approval Type Department [ ] Instructor [ ]
7. Variable Title [ ]
8. Honors [ ]
9. Full Time Privilege [ ]
10. Off Campus Experience [ ]

Schedule Type	Minutes Per Mtg	Meetings Per Week	Weeks Offered	% of Credit Allocated
Lecture	50	3	16	100
Recitation				
Presentation				
Laboratory				
Lab Prep				
Studio				
Distance				
Clinic				
Experiential				
Research				
Ind. Study				
Pract/Observ				

Cross-Listed Courses

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2012 MAY -2 AM 9:24

COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):
Restriction: Senior status in the College of Engineering or graduate level standing.
Concurrent prerequisites: (CE 41300 and CE 41400) or graduate standing.

See Attachment for Course Description

Professor Horton.

Calumet Department Head	Date	Calumet School Dean	Date	Calumet Undergrad Curriculum Committee	Date
Fort Wayne Department Head	Date	Fort Wayne School Dean	Date	Fort Wayne Chancellor	Date
Indianapolis Department Head	Date	Indianapolis School Dean	Date	R. Cipra Undergrad Curriculum Committee	1/17/2012 Date
North Central Department Head	Date	North Central School Dean	Date	APPROVED 4/26/12 Date Approved by Graduate Council	
M K Davis	11/18/11				
West Lafayette Department Head	Date	West Lafayette College/School Dean	Date	Graduate Council Secretary	Date
Yeong E. Liu	4/26/12		4/19/12	Susan L. Poage	4/30/12
Graduate Area Committee Convener	Date	Graduate Dean	Date	West Lafayette Registrar	Date
					5/1/12

OFFICE OF THE REGISTRAR

5/9/12

CE 51501

Supporting Document for a New Graduate Course

To: Purdue University Graduate Council

From:
Faculty Member: Travis Horton
Department: Civil Engineering
Campus: West Lafayette

Date: 11-28-11

Subject: Proposal for New Graduate Course-Documentation Required by the Graduate Council to Accompany Registrar's Form 40G

For Reviewer's comments only (Select One)

Reviewer:

Comments:

Contact for information if questions arise:
Name: Travis Horton
Phone Number: 494-6098
E-mail: wthorton@purdue.edu
Campus Address: CIVL G219

Course Subject Abbreviation and Number: CE ~~51500~~ 51501

Course Title: Building Energy Audits

A. Justification for the Course:

- Provide a complete and detailed explanation of the need for the course (e. g., in the preparation of students, in providing new knowledge/training in one or more topics, in meeting degree requirements, etc.), how the course contributes to existing majors and/or concentrations, and how the course relates to other graduate courses offered by the department, other departments, or interdisciplinary programs.

- Justify the level of the proposed graduate course (50000- or 60000-level) including statements on, but not limited to: (1) the target audience, including the anticipated number of undergraduate and graduate students who will enroll in the course; and (2) the rigor of the course.

B. Learning Outcomes and Method of Evaluation or Assessment:

- Describe the course objectives and student learning outcomes that address the objectives (i.e., knowledge, communication, critical thinking, ethical research, etc.).

- Describe the methods of evaluation or assessment of student learning outcomes. (Include evidence for both direct and indirect methods.)

- Grading criteria (select from dropdown box); include a statement describing the criteria that will be used to assess students and how the final grade will be determined.

Criteria: Papers and Projects

- Identify the method(s) of instruction (select from dropdown box) and describe how the methods promote the likely success of the desired student learning outcomes.

Method of Instruction Lecture

C. Prerequisite(s):

- List prerequisite courses by subject abbreviation, number, and title.
- List other prerequisites and/or experiences/background required. If no prerequisites are indicated, provide an explanation for their absence.

D. Course Instructor(s):

- Provide the name, rank, and department/program affiliation of the instructor(s).
- Is the instructor currently a member of the Graduate Faculty? ✓ Yes — No
  (If the answer is no, indicate when it is expected that a request will be submitted.)

E. Course Outline:

- Provide an outline of topics to be covered and indicate the relative amount of time or emphasis devoted to each topic. If laboratory or field experiences are used to supplement a lecture course, explain the value of the experience(s) to enhance the quality of the course and student learning. For special topics courses, include a sample outline of a course that would be offered under the proposed course.

F. Reading List (including course text):

- A primary reading list or bibliography should be limited to material the students will be required to read in order to successfully complete the course. It should not be a compilation of general reference material.
- A secondary reading list or bibliography should include material students may use as background information.

G. Library Resources

- Describe the library resources that are currently available or the resources needed to support this proposed course.

H. Example of a Course Syllabus (While not a necessary component of this supporting document, an example of a course syllabus is available, for information, by clicking on the link below, which goes to the *Graduate School's Policies and Procedures Manual for Administering Graduate Student Programs*. See Appendix K.)

http://www.gradschool.purdue.edu/downloads/Graduate_School_Policies_and_Procedures_Manual.pdf

CE 51501

51501
CE ~~51500~~ - Building Energy Audits

A. Justification for the Course:

Buildings in the U.S. continue to consume more and more energy – around 70% of the electricity and more than 30% of the primary energy. There currently exists a high demand for cost effective and timely energy conservation services that have the demonstrated ability to reduce energy consumption and overall operating costs of a building. This demand is attributable to several factors including:

- the escalating (and sometimes volatile) cost of electricity and natural gas;
- environmental concerns associated with the generation of electricity through the combustion of fossil fuels;
- the desire to reduce our National dependence on foreign energy sources; and
- an increasing demand being placed on our aging electrical grid.

The energy services industry has routinely shown that commercial buildings in general have the potential to reduce their energy consumption in excess of 50% of their current levels when they implement an aggressive energy management program. This course is instrumental in providing students with the skills necessary to evaluate energy consumption in buildings and to make appropriate recommendations for residential and commercial buildings that will enable a dramatic reduction in their energy footprint.

In this course, students use the American Society of Heating Refrigerating and Air-conditioning Engineers (ASHRAE) forms and procedures for completing Level 1 and Level 2 building energy audits. The students also learn appropriate energy modeling techniques and learn to use available building energy modeling software that is necessary to perform a Level 3 energy audit on a building.

The course provides a hands-on opportunity for students to complete two energy audits during the semester; one audit on a residential dwelling and another on a commercial building. During these audits students analyze and make realistic energy improvement recommendations based on their energy audit, and present their results to appropriate decision makers. This course was taught Fall 2009, Fall 2010, and Fall 2011 with enrollments of 15, 31, and 31, respectively.

This course is designed to provide students with the necessary skills to perform an energy audit on commercial and residential buildings. Energy accounting procedures for all major building subsystems are covered in detail, along with operational cost analysis of these systems. Students learn fundamental techniques for auditing the building envelope; electrical and lighting systems; heating, ventilation, and air conditioning systems; internal thermal loads; and building maintenance and operation procedures. Students also learn to analyze electric and natural gas utility tariffs and rate structures and apply their findings to the energy auditing process.

B. Learning Outcomes and Method of Evaluation or Assessment:

Course Learning Outcomes:

- Analyze utility tariffs and rate structures for electricity and natural gas, and use the information to help guide an energy audit.
- Perform an energy audit of all major building subsystems, including the building envelope, electrical and lighting systems, heating, ventilation, and air conditioning systems, internal thermal loads, and building maintenance and operation procedures.
- Numerically model the energy consumption of each of the building subsystems, and run parametric studies to determine and recommend appropriate energy conservation measures.

Assessing the course outcomes will take place through regular homework assignments, exams, quizzes, and projects.

Topics Covered:

- Understanding utility bills
- Energy conservation opportunity assessment
- Energy audit procedures
    a. Levels of effort
    b. Site visit
    c. Building envelope
    d. Electrical system
    e. HVAC system
    f. Physical plant
    g. Maintenance
- Energy modeling software (EnergyPlus)
- Distributed generation and combined heat and power systems
- Operational cost analysis

Methods of Evaluation and assessment

Homework and Projects:
Homework and projects will be assigned regularly. Assignments should be done neatly and submitted with final solutions clearly summarized and marked. Assignments turned in late will lose a minimum of 50% of the available points. Assignments that are more than a week late will not be accepted unless a specific arrangement has been made with the instructor prior to the due date.

Grading:
Your final course grade will be based on the following breakdown, note that the +/- grading system is not being used (i.e. 90.0% and up = A; 80.0% to 89.9% = B; 70.0% to 79.9% = C; 60.0% to 69.9% = D; 59.9% and below is an F)

Final grades will be based on the following breakdown

Homework	30%,
Exam	25%,
Projects	
Written	30%
Presentation	15%

Method of instruction
Lecture

C. **Prerequisite(s):**

- **Restriction:** Senior status in the College of Engineering or Graduate-level standing;
- **Concurrent prerequisites:** CE 41300 Building Envelope Design and Thermal Loads and CE 41400 Building Mechanical and Electrical System Design, or graduate standing.

D. **Course Instructor:**

Dr. W. Travis Horton, Assistant Professor, School of Civil Engineering with courtesy appointment in the School of Mechanical Engineering

Currently a member of the Graduate Faculty

E. **Course Outline:**

Week 1: **Introduction and Overview.** Introduction to the course plan and objectives; Define the scope and levels of effort of an energy audit; Overview of general auditing procedures; Example of a complete energy audit. [1 Week]

CE 5/501

Weeks 2-3: **Understanding Utility Billing Practices and Analyzing Rate Tariffs.** Introduction to regulated and de-regulated utilities; Analyzing electric utility rate structures; Analyzing natural gas utility rate structures; Linking rate tariffs to potential energy conservation measures. Assessing rate change opportunities. [2 weeks]

Week 4: **Inverse Building Modeling.** Defining appropriate energy usage indices; Correlating building energy usage to weather-related factors; Cumulative sum of errors and statistical change-point analysis. [1 week]

Weeks 5-8: **Auditing Major Building Sub-Systems.** Electrical and lighting audit; Building envelope audit; Internal loads, HVAC&R audit, Operations and maintenance audit; Instrumentation for energy auditing. [4 weeks]

Weeks 9-11: **Energy Estimating Techniques.** Weather bin modeling; Single variable regression analysis; HVAC energy estimating; Compressed air systems; Steam systems. [3 weeks]

Weeks 12-14: **Advanced Technology Opportunity Assessment.** Automated building energy management systems; Thermal energy storage systems; Combined heat and power systems. [3 weeks]

Week 15: **Continuous Building Monitoring and Improvement.** Total building commissioning; Financial analysis of energy conservation opportunities. [1 week]

F. Reading List (including course text):

- Krarti, M. (2011) Energy Audit of Building Systems: An Engineering Approach, 2nd edition, CRC Press

G. Library Resources:

- Thumann & W.J. Younger, Handbook of Energy Audits, 7th ed. The Fairmont Press
- Cowan,J. et al., Procedures for Commercial Building Energy Audits, American Society of heating, Refrigerating and Air-Conditioning Engineers, Inc.
- Capehart,B.L., W.C. Turner, & W.J. Kennedy, Guide to Energy Management, 5th ed. The Fairmont Press

H. Sample Syllabus

CE 51501

Fall Semester 2011 CE 597 BUILDING ENERGY AUDITS

Instructor:	Dr. W. Travis Horton
Office:	CIVL G219
Phone:	494-6098
Time:	TH 12:00 p.m. - 1:15 p.m.
Location:	CIVL 2118
Office Hours:	TH 1:15 p.m. - 2:00 p.m.

Textbook:	M. Krarti, Energy Audit of Building Systems: An Engineering Approach, 2nd edition, CRC Press, 2011
Reference:	1) A. Thumann & W.J. Younger, Handbook of Energy Audits, 7th ed. The Fairmont Press 2) J. Cowan, et al., Procedures for Commercial Building Energy Audits, American Society of heating, Refrigerating and Air-Conditioning Engineers, Inc. 3) B.L. Capehart, W.C. Turner, & W.J. Kennedy, Guide to Energy Management, 5th ed. The Fairmont Press

Restrictions: Senior status in the College of Engineering or Graduate-level standing;
Concurrent pre-requisites: CE 41400 Building Mechanical and Electrical System Design and CE 41300 Building Envelope Design and Thermal Loads, or graduate standing.

Course Objectives:
This course is designed to provide students with the necessary skills to perform an energy audit on commercial and residential buildings. Energy accounting procedures for all major building subsystems are covered in detail, along with operational cost analysis of these systems. Students learn fundamental techniques for auditing the building envelope; electrical and lighting systems; heating, ventilation, and air conditioning systems; internal thermal loads; and building maintenance and operation procedures. Students also learn to analyze electric and natural gas utility tariffs and rate structures and apply their findings to the energy auditing process. In this course students use the American Society of Heating Refrigerating and Air-conditioning Engineers (ASHRAE) forms and procedures for completing Level 1 and Level 2 building energy audits, and learn to use available building energy modeling software that is necessary to perform a Level 3 energy audit. The course provides a hands-on opportunity for students to complete two energy audits during the semester; one audit on a residential dwelling and another on a commercial building. During these audits students analyze and make realistic energy improvement recommendations based on their energy audit, and present their results to appropriate decision makers.

Homework and Projects:
Homework and projects will be assigned regularly. Assignments should be done neatly and submitted with final solutions clearly summarized and marked. Assignments turned in late will lose a minimum of 50% of the available points. Assignments that are more than a week late will not be accepted unless a specific arrangement has been made with the instructor prior to the due date.

Mid-Term Exam:
A mid-term exam will be given during the semester. The exam must be taken in class on the scheduled day. Students with conflicts must make arrangements to take a make-up exam with the instructor at least one week prior to the scheduled exam.

Grading:
Your final course grade will be based on the following breakdown, note that the +/- grading system is not being used (i.e. 90.0% and up = A; 80.0% to 89.9% = B; 70.0% to 79.9% = C; 60.0% to 69.9% = D; 59.9% and below is an F)

Final grades will be based on the following breakdown
Homework 30%,
Exam 25%,
Projects
Written 30%
Presentation 15%

Grade challenge policy:
Any challenges to a grade received on an assignment, exam, or project must be submitted to the instructor in writing within one week of receiving the grade.

Topics Covered:
2. Understanding utility bills
3. Energy conservation opportunity assessment
4. Energy audit procedures
    a. Levels of effort
    b. Site visit
    c. Building envelope
    d. Electrical system
    e. HVAC system
    f. Physical plant
    g. Maintenance
5. Energy modeling software (EnergyPlus)
6. Distributed generation and combined heat and power systems
7. Operational cost analysis

CE 51501

Special Accommodations:
If you require special accommodations because of a disability, please inform the instructor of your needs by the end of the first week.

Emergencies:
In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Any changes will be posted to the course blackboard site.

Academic Integrity:
Academic dishonesty will not be tolerated. Please refer to the section, "Definition of Academic Dishonesty," on the following web page: http://www.purdue.edu/odos/osrr/integrity.htm. Any incidents of academic dishonesty will, at the very least, result in zero credit for the associated assignment, quiz, or project. Further penalties, such as immediate failure of the course and/or referral to the Dean of Students, are at the discretion of the instructor.

CE 51501

TO: The Faculty of the College of Engineering

FROM: The Faculty of the School of Civil Engineering

RE: New Graduate Course, CE ~~51500~~ 51501 Building Energy Audits

The faculty of the School of Civil Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

CE 51500 **Building Energy Audits**
Sem. 1 or Sem 2, Lecture 3, Cr. 3.
Restriction: Senior status in the College of Engineering or graduate-level standing;
Concurrent prerequisites: CE 41400 Building Mechanical and Electrical System Design and CE 41300 Building Envelope Design and Thermal Loads, or graduate-level standing.

Description: This course is designed to provide students with the necessary skills to perform an energy audit on commercial and residential buildings. Energy accounting procedures for all major building subsystems are covered in detail, along with operational cost analysis of these systems. Students learn fundamental techniques for auditing the building envelope; electrical and lighting systems; heating, ventilation, and air conditioning systems; internal thermal loads; and building maintenance and operation procedures. Students also learn to analyze electric and natural gas utility tariffs and rate structures and apply their findings to the energy auditing process.

Reason: Buildings in the U.S. continue to consume more and more energy – around 70% of the electricity and more than 30% of the primary energy. There currently exists a high demand for cost effective and timely energy conservation services that have the demonstrated ability to reduce energy consumption and overall operating costs of a building. This demand is attributable to several factors including, the escalating (and sometimes volatile) cost of electricity and natural gas; environmental concerns associated with the generation of electricity through the combustion of fossil fuels; the desire to reduce our National dependence on foreign energy sources; and an increasing demand being placed on our aging electrical grid. The energy services industry has routinely shown that commercial buildings in general have the potential to reduce their energy consumption in excess of 50% of their current levels when they implement an aggressive energy management program. This course is instrumental in providing students with the skills necessary to evaluate energy consumption in buildings and to make

APPROVED BY THE FACULTY
OF THE SCHOOL OF ENGINEERING
BY THE ENGINEERING
CURRICULUM COMMITTEE
ECC Minutes #9
Date 1-17-2012
Chairman ECC R. Cipra

CE 51501

appropriate recommendations for residential and commercial buildings that will enable a dramatic reduction in their energy footprint. In this course students use the American Society of Heating Refrigerating and Air-conditioning Engineers (ASHRAE) forms and procedures for completing Level 1 and Level 2 building energy audits. The students also learn appropriate energy modeling techniques and learn to use available building energy modeling software that is necessary to perform a Level 3 energy audit on a building. The course provides a hands-on opportunity for students to complete two energy audits during the semester; one audit on a residential dwelling and another on a commercial building. During these audits students analyze and make realistic energy improvement recommendations based on their energy audit, and present their results to appropriate decision makers. This course was taught Fall 2009, Fall 2010, and Fall 2011 with enrollments of 15, 31, and 31, respectively.

M.K. Banks
Bowen Engineering Head and Professor
Jack and Kay Hockema Professor of Civil Engineering