Office of the Registrar
FORM 40 REV. 5/11

PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION, OR REVISION OF AN UNDERGRADUATE COURSE (10000-40000 LEVEL)

Print Form

EFD 12-12 (201310)

.PARTMENT Civil Engineering — EFFECTIVE SESSION Fall 2012

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

- [X] 1. New course with supporting documents
- [ ] 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 (department head signature only)
- [ ] 8. Change in instructional hours
- [ ] 9. Change in course description
- [ ] 10. Change in course requisites
- [ ] 11. Change in semesters offered (department head signature only)
- [ ] 12. Transfer from one department to another

PROPOSED:
Subject Abbreviation CE
Course Number 41300
Long Title Building Envelope Design and Thermal Loads
Short Title Bldg Envelp Dsgn & Thrml Load

EXISTING:
Subject Abbreviation
Course Number

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 [ ] Cont Ed [ ] Ft. Wayne [ ] Indianapolis [ ] N. Central [ ] Tech Statewide [X] W. Lafayette

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 [ ]

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. Fees: [ ] Coop [ ] Lab [ ] Rate Request
Include comment to explain fee
6. Registration Approval Type Department [ ] Instructor [ ]
7. Variable Title [ ]
8. Honors [ ]
9. Full Time Privilege [ ]
10. Off Campus Experience [ ]

ScheduleType	Minutes Per Mtg	Meetings Per Week	Weeks Offered	% of Credit Allocated
ture	50	3	16	100
:itation				
Presentation				
Laboratory				
Lab Prep				
Studio				
Distance				
Clinic				
Experiential				
Research				
Ind. Study				
Pract/Observ				

Cross-Listed Courses

2012 JAN 23 AM 10:02
RECEIVED

COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):
Restriction: Junior or higher standing in the College of Engineering.
Prerequisite: CE 31100 Architectural Engineering or instructor permission

See Attachment for Course Description

*COURSE LEARNING OUTCOMES:

See Attachment for Course Learning Outcomes

Calumet Department Head	Date	Calumet School Dean	Date
Fort Wayne Department Head	Date	Fort Wayne School Dean	Date
Indianapolis Department Head	Date	Indianapolis School Dean	Date
Central Faculty Senate Chair	Date	Vice Chancellor for Academic Affairs	Date
West Lafayette Department Head [signature]	11/18/11	West Lafayette College/School Dean [signature]	1/1/12

West Lafayette Registrar [signature] 1/27/12 Date

OFFICE OF THE REGISTRAR

LD 1/25/12

Form 40 Attachment 1 for CE 41300

CE 41300 BUILDING ENVELOPE DESIGN and THERMAL LOAD CALCULATIONS

Course Description (Include Requisites/Restrictions):
Restriction: Junior or higher standing in the College of Engineering;
Prerequisite: CE 31100 or Instructor permission.

This course discusses the basic thermal processes in buildings and presents comprehensive methods for thermal design of envelope assemblies in commercial and residential buildings. The first part of the course includes steady-state and transient conduction through envelope assemblies, convection and radiation heat transfer in buildings, solar radiation and solar gains, thermal performance of windows, internal gains, ventilation and infiltration. The second part of the course considers surface and room energy balance equations and presents analytical and computational models for calculation of hourly heating and cooling loads throughout the year. Climatic-based standards, passive solar design, advanced energy guides, and innovative technologies for high performance buildings are discussed. The course also includes a design project on analytical heating/cooling load calculations for a commercial building.

Course Learning Outcomes:

Upon completion of this course, students will be able to:

- Calculate heat transfer through envelope assemblies for commercial and residential buildings.
- Solve energy balance equations for building surfaces and room air.
- Calculate solar and internal gains and predict transient hourly heating and cooling loads for a building throughout the year using analytical and computational models.
- Design building envelopes according to national standards.
- Understand principles of passive solar design and the application of innovative envelope technologies.

TO: The Faculty of the College of Engineering

FROM: The Faculty of the School of Civil Engineering

RE: New Undergraduate Course: CE 41300 Building Envelope Design and Thermal Loads

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 41300 **Building Envelope Design and Thermal Loads**
Sem. 1 or Sem. 2, Lecture 3, Cr. 3.
Restriction: Junior or higher standing in the College of Engineering.
Prerequisite: CE 31100 Architectural Engineering or instructor permission

Description: This course discusses the basic thermal processes in buildings and presents comprehensive methods for thermal design of envelope assemblies in commercial and residential buildings. The first part of the course includes steady-state and transient conduction through envelope assemblies, convection and radiation heat transfer in buildings, solar radiation and solar gains, thermal performance of windows, internal gains, ventilation and infiltration. The second part of the course considers surface and room energy balance equations and presents analytical and computational models for calculation of hourly heating and cooling loads throughout the year. Climatic-based standards, passive solar design, advanced energy guides, and innovative technologies for high performance buildings are discussed. The course also includes a design project on analytical heating/cooling load calculations for a commercial building.

Reason: This is the first design course of the Architectural Engineering emphasis area in Civil Engineering. Students learn about thermal design of building envelope assemblies according to national standards and use fundamental energy balance equations in order to calculate building heating and cooling loads using appropriate climatic information. The implementation of novel building technologies is discussed as a way to reduce energy consumption in new and existing buildings. The course was taught as CE 497XX in Fall 2009 and Fall 2010 with enrollments of 34 and 37 students respectively. (28 students are currently enrolled in Fall 2011.)

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

APPROVED ... FACULTY
OF THE SCH... ENGINEERING
BY T...
CURR... COMMITTEE

ECC Minutes #9
Date 1-17-2012
Chairman R. Cipra

CE 41300 BUILDING ENVELOPE DESIGN AND THERMAL LOADS

Course Instructor: Athanasios Tzempelikos

Level: Undergraduate Level

Restriction: Junior (or higher) standing in the College of Engineering.
Prerequisite: CE 31100 Architectural Engineering or instructor permission

Course outcomes: Upon completion of this course, the students will be able to:

- Calculate heat transfer through envelope assemblies for commercial and residential buildings.
- Solve energy balance equations for building surfaces and room air.
- Calculate solar and internal gains and predict transient hourly heating and cooling loads for a building throughout the year using analytical and computational models.
- Design building envelopes according to national standards.
- Understand principles of passive solar design and the application of innovative envelope technologies.

Course outline:

- **Building systems and the built environment –** Energy use in buildings; urban microclimate; introduction to building science; building systems and domains; atmosphere and climate and their effect on buildings and occupants (1 week)
- **The building envelope** –Wall construction types and materials; cavity, barrier and mass walls; facades; foundation and basement wall thermal details; roof construction thermal design; curtain wall details; thermal bridges; residential envelope construction and the role of insulation; test methods for heat, air and water leakage (2 weeks)
- **Steady-state and transient heat conduction through building opaque sections** –Prediction of steady state heat flow and temperature gradients in single and multi-layered walls; parallel heat flows in real wall assemblies with thermal bridges; heat transfer through doors, ceilings, roofs, attic spaces, basements, window frames, pipes; Transient RC networks for heat transfer through walls; performance design tables and introduction to ASHRAE energy design guides (2 weeks)
- **Convection and radiation heat transfer in buildings-** Internal and external convective surface coefficients; grey surfaces; long wave radiative heat exchange between building surfaces; view factor calculations; exterior surface radiation models (2 weeks)
- **Windows -** Solar and optical properties of windows; coatings; combined convection and radiation film coefficients; window overall thermal resistance and conductance calculations; performance metrics and specification tables (1 week)

- **Solar radiation in buildings -** Solar geometry; direct and diffuse solar radiation models; solar irradiance on exterior building surfaces; transmission through windows; shading calculations and design methods; solar heat gain coefficients and performance design tables (2 weeks)
- **Infiltration and Heating load calculation–** Air leakage calculation methods; infiltration conductance calculation; energy cost of infiltration; climatic data and heating design information; calculation of peak heating load for residential and commercial buildings (1 week)
- **Energy balance equations and building cooling load calculation-** Calculation of energy flows in rooms; thermal storage; room energy balance; transient thermal network approach; cooling climatic design information; internal gains; semi-transient models and the heat balance method; peak loads (2 weeks)
- **Building simulation, energy guides, and advanced technologies** – Basic modeling methods; building simulation software; ASHRAE energy design guides and ASHRAE Standards; passive solar design; high performance windows and walls; renewable energy technologies in buildings; daylighting and lighting controls; smart buildings (2 weeks)

Total: 15 weeks

Course website: Purdue Blackboard

Textbooks:

- **Main textbook:** Heating, Ventilating and Air Conditioning -Analysis and Design, sixth edition, by Mc Quinston, Parker & Spitler. John Wiley & Sons Inc., 2005.
- **Reference book:** ASHRAE Handbook-Fundamentals, American Society of Heating, Refrigeration and Air-conditioning Engineers, Atlanta, 2009.
- **Class notes,** design tables, papers and lecture slides are regularly provided to the students

Grading: Homework assignments, projects and two midterm exams will contribute to grading. Final grades will be based on the following weighting:

- **Homework assignments: 20%**
- **1st midterm exam: 25%**
- **2nd midterm exam: 25%**
- **Project: 30%**

The most recent course syllabus is appended on the following pages.

CE 49700 Building Envelope Design and Thermal Loads

Course objectives: The goal of the course is to design building envelopes for energy efficiency and to calculate thermal loads in commercial and residential buildings. Building technologies will be explored and modeled to reduce energy use in buildings, which accounts for more than 30% of the total energy consumption in the US. Lectures cover the basic physical processes in buildings and the related energy balance equations. These include heat transfer though different building envelope components for several types of construction; convection from internal and external surfaces; radiation heat transfer in rooms; solar radiation and solar gains; windows; internal gains; ventilation and infiltration; and lighting. Minimum and advanced standard requirements for envelope thermal design and internal gains will be followed according to ASHRAE standards. The final objective of this course is to build and solve transient computational models in order to calculate energy flows in buildings and to estimate thermal (heating and cooling) loads and energy demand while achieving a comfortable indoor environment.

Instructor: Thanos Tzempelikos

Class time and location: Tuesday-Thursday 1:30-2:45pm, Room CIVL 2123

Office hours: Tuesday-Thursday 2:45-4:00pm, Room CIVL G225

Restrictions: Junior (or higher) standing in the College of Engineering.
Prerequisites: CE 31100 Architectural Engineering or permission from the instructor

Textbooks:
Main textbook: Heating, Ventilating and Air Conditioning -Analysis and Design, sixth edition, by McQuinston, Parker & Spitler. John Wiley & Sons Inc., 2005.
- **Reference book:** ASHRAE Handbook-Fundamentals, American Society of Heating, Refrigeration and Air-conditioning Engineers, Atlanta, 2009.
- **Class notes and selected papers** will be provided regularly

Course Website: Purdue Blackboard

Attendance: Students are expected to attend all classes.

Grading: **Homework assignments, projects and two midterm exams will contribute to grading. Final grades will be based on the following weighting:**

Homework assignments: 20%
1st midterm exam: 25%
2nd midterm exam: 25%
Project: 30%

Homework:

- Homework will be assigned in class and will be also posted on the course web site
- Homework should be handed in only at the beginning of class due
- All assignment set problems must be handed in at the same time
- Work should be presented in a logical manner, must be well-organized and clean

Design Projects: Each student will participate in a group of 2 (maximum) for completing the required course project. The project themes for each group will be decided by the end of October and final project presentations will be done in the last classes. The project themes could cover a wide variety of energy-efficient building designs and related technologies; however all projects will involve analytical heating and cooling load calculations for specific commercial buildings.

Units: Both SI and US units will be used in lectures, homework, projects, and examinations.

Special Accommodations: If you require special accommodations because of a disability, please inform me 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. Information about changes in this course are provided through:

- Course website (Blackboard)
- E-mail: ttzempel@purdue.edu

Ethics: 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 or exam. Further penalties, such as immediate failure of the course and/or referral to the Dean of Students, are at the discretion of the instructor.

DETAILED COURSE OUTLINE

Buildings and their functions: Building systems & domains- general descriptions; Atmosphere and climate and their effect on buildings and occupants

The building envelope: Envelope parts and descriptions; Construction types and materials; Introduction to physical processes in buildings: heat, air and light transfer

Heat gains and losses in buildings – introduction: Conduction, convection and radiation; Thermal resistance/conductance definition and equations

Steady-state heat conduction through building opaque sections: Wall construction types; Fourier's law and heat flow; Predicting heat flow and temperature gradients; Single layered walls; Multi-layered walls and parallel heat flows; Thermal bridging; Floors, roofs, basements, below-grade construction and attics

Convection heat transfer in rooms: Convective surface coefficients and temperature dependence

Thermal radiation in buildings: Blackbody radiation; Radiative heat exchange; Long wave radiation emission; Radiation heat transfer between building surfaces; View factors calculations; Grey-surface approximations and radiative surface coefficients from interior and exterior building surfaces

Windows: Window types; Solar and optical properties of windows; Heat transfer through window cavities; Combined convection and radiation – film coefficients; Window overall thermal resistance and conductance calculations; ASHRAE methods and metrics

Solar radiation: Solar geometry; Extraterrestrial solar radiation; Solar radiation on earth's surface; Direct and diffuse solar radiation models- ASHRAE and Hottel's radiation models; Solar irradiance on exterior building surfaces; Solar radiation through windows; Absorption by interior building surfaces

Shading: Shading types and geometries; Shading devices and properties; Shading design calculations; ASHRAE methods and metrics

Infiltration and ventilation: Air leakage calculation methods; Wind effects; Energy cost of infiltration

Internal gains: Lighting; Equipment; People; Design standards

Energy balance calculations: Calculation of energy flows; Thermal storage; Room energy balance; Thermal network approach

Calculation of building thermal loads: Climatic information; Steady-state models; Space heating load; Space cooling load ; Semi-transient models and the heat balance method; Peak loads and mechanical system sizing

Energy calculations and building simulation: Basic modeling methods; Building simulation software; ASHRAE Energy guides- Standard 90.1

Energy-efficient buildings and advanced technologies: Passive solar design; High performance windows and walls; Renewable energy technologies in buildings; Daylighting and lighting controls; Natural ventilation; Smart buildings and BMS.