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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. No. 12-3a

EFD 16-12

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:

Subject Abbreviation CE

Course Number 51300

Long Title Lighting in Buildings

Short Title Lighting in Buildings

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

EXISTING:

Subject Abbreviation

Course Number

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 [ ]
4. Thesis 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. 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	2	16	67
Recitation				
Presentation				
Laboratory	120	1	16	33
Lab Prep				
Studio				
Distance				
Clinic				
Experiential				
Research				
Ind. Study				
Pract/Observ				

Cross-Listed Courses

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COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):

Restrictions: Senior status in the College of Engineering or graduate level standing.
Concurrent prerequisite: CE 41300 or graduate standing.

See attachment for Course Description

Professor Tzempelikos.

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 1/17/2012 Undergrad Curriculum Committee — Date
M K Banks 11/18/11 North Central Department Head — Date	[signature] 1/18/12 North Central School Dean — Date	APPROVED 4/26/12 Date Approved by Graduate Council
George E. Tin 4/26/12 West Lafayette Department Head — Date	West Lafayette College/School Dean — Date	[signature] 4/30/12 Graduate Council Secretary — Date
George E. Tin 4/26/12 Graduate Area Committee Convener — Date	Graduate Dean — Date	[signature] 5/2/12 West Lafayette Registrar — Date

OFFICE OF THE REGISTRAR

UD 5/8/12

CE 51300

Form 40 Attachment 1 for **CE 51300**

CE 51300 LIGHTING IN BUILDINGS

Course Description (Include Requisites/Restrictions):
Restriction: Graduate or senior level undergraduate standing
Prerequisite: CE 41300 or graduate standing

This course focuses on the design of illumination systems in buildings (electric and natural lighting) in order to achieve energy efficiency and visual comfort. The first part of the course includes analytical lighting calculation techniques, visual perception, radiative transfer, lamp characteristics, electric lighting system design and control for calculation of required indoor illuminance levels. The second part of the course covers daylighting (natural lighting) systems, including state-of-the-art daylighting prediction models as well as design and control of such devices and advanced metrics. The course also has a lab section, in which the students learn how to work with lighting and daylighting tools and build their own computational transient lighting models in open programming languages, in order to design illumination systems and predict electricity consumption and potential energy savings.

Course Learning Outcomes:

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

- Understand fundamental illumination concepts
- Design and assess the performance of electric and natural lighting systems in buildings.
- Calculate fundamental illuminance, non-point sources, radiant energy, lamp types, lighting controls, interior lighting design, daylight prediction models, optical properties of windows, advanced metrics and shading devices.
- Build and solve lighting and daylighting models using advanced software and programming techniques to design lighting systems and calculate energy savings from the use of natural light and lighting controls.
- Design a project, submit a project report and make an oral presentation (only individual projects are allowed). The project themes cover a wide variety of lighting/daylighting design and control such as: daylighting and lighting design of commercial buildings, measurements/monitoring of lighting levels in laboratory settings, prediction of potential energy savings, impact of shading design and control, and advanced daylighting system modeling.

CE 51300

Supporting Document for a New Graduate Course

To:	Purdue University Graduate Council	
From:	Faculty Member:	Athanasios Tzempelikos
	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: Athanasios Tzempelikos

Phone Number: 49-67586

E-mail: ttxempel@purdue.edu

Campus Address: CIVL G225

Course Subject Abbreviation and Number: CE 51300

Course Title: Lighting in Buildings

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

CE 51300

- 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 51300 - Lighting in Buildings

A. Justification for the Course:

Lighting accounts for at least 30% of the energy consumption in commercial buildings. This course introduces students to photometric quantities, lighting calculation techniques and electric lighting design in buildings.

Daylighting systems are explored in detail, to assess the potential of using such systems in order to substitute and supplement electric lighting.

Integration of these systems with electric lighting controls allows for significant reduction in lighting energy consumption.

The lab session helps students to learn how to work with advanced lighting software and advanced programming which are used for research and real application projects. The course was taught in Spring 2010 and Spring 2011 with enrollments of 13 and 22 students respectively. This is one of the few advanced lighting courses offered in the nation.

B. Learning Outcomes and Method of Evaluation or Assessment:

Course Learning Outcomes:

- Understand fundamental illumination concepts.
- Design and assess the performance of electric and natural lighting systems in buildings.
- Calculate fundamental illuminance, non-point sources, radiant energy, lamp types, lighting controls, interior lighting design, daylight prediction models, optical properties of windows, advanced metrics and shading devices.
- Build and solve lighting and daylighting models using advanced software and programming techniques to design lighting systems and calculate energy savings from the use of natural light and lighting controls.
- Design a project, submit a project report and make an oral presentation (only individual projects are allowed). The project themes cover a wide variety of lighting/daylighting design and control such as: daylighting and lighting design of commercial buildings, measurements/monitoring of lighting levels in laboratory settings, prediction of potential energy savings, impact of shading design and control, and advanced daylighting system modeling.

Methods of Evaluation and assessment

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

- Homework assignments: 20%
- 1st midterm exam: 25%
- 2nd midterm exam: 25%
- Course lab project - presentation: 30%

Homework:

- Homework will be assigned in class.
- 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.
- Collaboration with classmates is NOT allowed.
- Students found copying homework will be given zero credit at the end of semester.
- Solutions will be posted on the course website.

Design Projects:

Each student is required to complete a design project, submit a project report and make an oral presentation. Only individual projects are allowed. The project themes could cover a wide variety of lighting/daylighting design and control and will involve use of the software learned in the lab. *Example topics:* daylighting and lighting design of commercial buildings, lighting performance of the new AE labs, measurements and monitoring of lighting levels in existing buildings and prediction of potential energy savings, impact of shading design and control, advanced daylighting systems.

Method of instruction
Lecture

C. **Prerequisite(s):**

CE 41300 or Senior/Graduate standing in Engineering

D. Course Instructor:

Dr. Athanasios Tzempelikos, 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 review of basic concepts**
Nature of light and seeing; Basic photometric quantities

Week 2: **Lighting metrics, calculations and measurements**
Lighting terms and metrics; Inverse square law; Luminance equations; Lambertian surfaces and diffusion; The sky as a source; Measuring luminous flux; General square law in 3D; Zonal lumens for light sources.

Week 3: **Illuminance from non-point sources**
Strip, tube and rectangular sources; General flux transfer theory.

Week 4: **Vision and color**
Spectral sensitivity; Luminous efficacy; Vision factors; Contrast and brightness.

Week 5: **Radiant energy and light**
Spectral power density; Blackbody radiation; Emissivity and selective radiators; Luminescence and incandescence; Relating lumens and watts; Color temperature.

Week 6: **Lamps**
Incandescent; Tungsten-halogen; Fluorescent; Compact fluorescent lamps: development, properties, construction, types, life and losses, and efficiency; Ballasts; Circuits and starting methods; Mercury, metal halide and high-pressure sodium lamps.

Week 7: **Luminaires and controls for interior lighting**
Criteria: Luminaire characteristics and classifications; Luminaire luminance and optics –glare criteria; Photometric reports and information; Visual comfort and glare indices.

Week 8: **Lighting controls:**
Functions; Occupancy sensing types; Control circuit types; Scheduling; Task tuning; Daylight harvesting; Load shedding.

Week 9: **Interior lighting design: average illuminance**
Factors and parameters; Illuminance selection; The lighting design process; Basic lumen method: cavity ratios, effective reflectances, coefficients of utilization, initial average illuminance, light loss factors, luminaire spacing, reference tables and reports; Introduction to luminous exitance; Non-rectangular spaces.

Week 10: **Interior lighting design: detailed illuminance calculations**
Detailed Flux transfer; Luminous exitance and relationships; Configuration factors and properties; Form/view factors and properties; One-bounce flux transfer analysis; Multiple-bounce analysis, full radiosity method and detailed illuminance calculations.

Week 11: **Introduction to Daylighting**
- Basic daylighting models (CIE and ASHRAE sky models);
- Solar geometry and model similarities.

Week 12: **Detailed daylighting prediction models**
- The Perez all weather sky models;
- Weather data and detailed model formulation.

Week 13: **Windows and optics**
- Optical properties as fundamental variables;
- Angle dependency; Basic ray tracing for optical properties;
- Selective glazings and coatings for daylighting.

Week 14: **Daylighting metrics and calculations**
- Daylight factors; Illuminance histograms; Useful illuminances;
- Daylight autonomy; Energy savings from daylighting.

Week 15: **Shading**
- Shading devices: types, properties and controls;
- Research on lighting and daylighting and applications

Week 16 **Midterm exam 2**

F. Reading List (including course text):

- Murdoch, J.B. (2003) Illuminating Engineering –from Edison's Lamp to the Laser, 2nd edition, Visions Communications.
- Handouts, articles and selected papers will be given regularly and will cover a significant part of the course.

G. Library Resources:

- Murdoch (2003)) Illuminating Engineering –from Edison's Lamp to the Laser, is available on library reserve

H. Sample Syllabus

CE 59700: Lighting in Buildings

Lectures:

Tuesday-Thursday 1:30-2:20 pm in CIVL 3153

Lab hours:

Tuesday 3:30-5:20 pm in PHYS 116

Instructor:

Athanasios Tzempelikos (ttzempel@purdue.edu)

Office Hours: Tuesday 2:30-3:30 pm (CIVL G225) + lab hours

Prerequisites:

Senior/graduate standing in Engineering

Course objectives:

Lighting accounts for at least 30% of the energy consumption in commercial buildings. This course will focus on the design of illumination systems in buildings (electric and natural lighting) in order to achieve energy-efficiency and visual comfort. The first part includes lighting calculation techniques, visual perception, radiative transfer, lamp characteristics, and electric lighting system design for calculation of required illuminance. The second part of the course will focus on daylighting (natural lighting) systems, including daylighting predictive models as well as design and control of such devices. Integration of these systems with electric lighting controls allows for significant reduction in lighting energy consumption. The course has a lab section, in which the students learn how to work with lighting and daylighting software, in order to design illumination systems and predict electricity consumption and potential energy savings.

Textbooks:

- **Main textbook:** "Illuminating Engineering –from Edison's lamp to the laser", 2nd edition, by J.B. Murdoch, Visions Communications, 2003.
- **Handouts, articles and selected papers** will be given regularly and will cover a significant part of the course.

Course Website:

Purdue Blackboard

Attendance:

Students are expected to attend all classes.

CE 51300

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%
- Course lab project – presentation: 30%

Homework:

- Homework will be assigned in class
- 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
- Collaboration with classmates is NOT allowed
- Students found copying homework will be given zero credit at the end of semester
- Solutions will be posted on the course website

Design Projects:

Each student is required to complete a design project, submit a project report and make an oral presentation. Only individual projects are allowed. The project themes could cover a wide variety of lighting/daylighting design and control and will involve use of the software learned in the lab. *Example topics:* daylighting and lighting design of commercial buildings, lighting performance of the new AE labs, measurements/monitoring of lighting levels in existing buildings and prediction of potential energy savings, impact of shading design and control, advanced daylighting systems.

Projects will start in February with submission of an abstract and the final report is due April 26.

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. Here are ways to get information about changes in this course:

- 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.

COURSE OUTLINE

Introduction and review of basic concepts
Nature of light and seeing , Basic photometric quantities

Lighting metrics, calculations and measurements
Lighting terms and metrics, Inverse square law, Luminance equations, Lambertian surfaces and diffusion, The sky as a source, Measuring luminous flux, General square law in 3D, Zonal lumens for light sources

Illuminance from non-point sources
Strip, tube and rectangular sources, General flux transfer theory

Vision and color
Spectral sensitivity, Luminous efficacy, Vision factors, Contrast and brightness

Radiant energy and light
Spectral power density, Blackbody radiation, Emissivity and selective radiators, Luminescence and incandescence, Relating lumens and watts, Color temperature

Lamps
Incandescent, Tungsten-halogen, Fluorescent, Compact fluorescent lamps: development, properties, construction, types, properties, life and losses, efficiency, Ballasts, Circuits and starting methods, Mercury, metal halide and high-pressure sodium lamps

Luminaires and controls for interior lighting
Criteria, Luminaire characteristics and classifications, Luminaire luminance and optics –glare criteria, Photometric reports and information, Visual comfort and glare indices

Lighting controls:
Functions, Occupancy sensing types , Control circuit types, Scheduling, Task tuning, Daylight harvesting, Load shedding

Interior lighting design: average illuminance
Factors and parameters, Illuminance selection, The lighting design process, Basic lumen method: cavity ratios, effective reflectances, coefficients of utilization, initial average illuminance, light loss factors, luminaire spacing, reference tables and reports, Introduction to luminous exitance, Non-rectangular spaces

Interior lighting design: detailed illuminance calculations
Detailed Flux transfer , Luminous exitance and relationships, Configuration factors and properties, Form/view factors and properties, One-bounce flux transfer analysis, Multiple-bounce analysis, full radiosity method and detailed illuminance calculations

Project descriptions

Introduction to Daylighting
Basic daylighting models (CIE and ASHRAE sky models), Solar geometry and model similarities

Detailed daylighting prediction models
The Perez all weather sky models , Weather data and detailed model formulation

Windows and optics
Optical properties as fundamental variables, Angle dependency, Basic ray tracing for optical properties, Selective glazings and coatings for daylighting

Daylighting metrics and calculations
Daylight factors, Illuminance histograms, Useful illuminances, Daylight autonomy, Energy savings from daylighting

Shading
Shading devices: types, properties and controls, Research on lighting and daylighting and applications

CE 51300

TO: The Faculty of the College of Engineering

FROM: The Faculty of the School of Civil Engineering

RE: New graduate course: CE 51300 Lighting in Buildings

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 51300 **Lighting in Buildings**
Sem. 1 or Sem. 2, Lecture 2, Lab 2, Cr. 3.
Restriction: Graduate or senior level undergraduate standing
Prerequisite: CE 41300 Building Envelope Design and Thermal Loads or graduate standing

Description: This course focuses on the design of illumination systems in buildings (electric and natural lighting) in order to achieve energy efficiency and visual comfort. The first part of the course includes analytical lighting calculation techniques, visual perception, radiative transfer, lamp characteristics, electric lighting system design and control for calculation of required indoor illuminance levels. The second part of the course covers daylighting (natural lighting) systems, including state-of-the-art daylighting prediction models as well as design and control of such devices and advanced metrics. The course also has a lab section, in which the students learn how to work with lighting and daylighting tools and build their own computational transient lighting models in open programming languages, in order to design illumination systems and predict electricity consumption and potential energy savings.

Reason: Lighting accounts for at least 30% of the energy consumption in commercial buildings. This course introduces students to photometric quantities, lighting calculation techniques and electric lighting design in buildings. Daylighting systems are explored in detail, to assess the potential of using such systems in order to substitute and supplement electric lighting. Integration of these systems with electric lighting controls allows for significant reduction in lighting energy consumption. The lab session helps students to learn how to work with advanced lighting software and advanced programming which are used for research and real application projects. The course was taught in Spring 2010 and Spring 2011 with enrollments of 13 and 22 students respectively. This is one of the few advanced lighting courses offered in the nation.

MKBanks

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

APPROVED FOR THE FACULTY
OF THE SCHOOLS OF ENGINEERING
BY THE ENGINEERING
CURRICULUM COMMITTEE

ECC Minutes #9

Date 1-17-2012

Chairman ECC R. Cipra