TO: The Faculty of the College of Engineering

FROM: School of Electrical and Computer Engineering of the College of Engineering

RE: New Graduate Course, ECE 50834 Visualization Techniques

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

ECE 50834 Visualization Techniques
Sem. 1, Lecture 3, Cr. 3.

Prerequisite: Graduate Standing or ECE 36800, ECE 36900 (or equivalent)

Prerequisite by Topic: Programming, Data Structures; Discrete Math

Description: This course covers topics in and algorithms for visualization: scientific visualization, medical visualization, information visualization, and volume rendering techniques. Fundamental algorithms, advanced techniques, design criteria, and application specific issues will be explored.

Reason: Visualization has become a fundamental tool for engineering and science. This course will prepare computer engineering students, as well as engineering and science students to effectively use, evaluate, design, and develop visualizations and visualization software. Computer graphics and visualization are important, fundamental components of modern computer engineering. Therefore, we need this course to educate our students on the basic algorithms, techniques, and tools of this field.

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Michael R Melloch

Michael R. Melloch, Associate Head
School of Electrical and Computer Engineering

Office of the Registrar
FORM 40G REV. 4/13

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

DEPARTMENT: Electrical and Computer Engineering — EFFECTIVE SESSION: Spring 2017

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	ECE	Subject Abbreviation	
Course Number	50834	Course Number	
Long Title	Visualization Techniques		
Short Title	Visualization Techniques		

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

TERMS OFFERED
Check All That Apply:
- [x] Fall
- [ ] 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. 3.0
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. 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 [ ]

Schedule Type	Minutes Per Mtg	Meetings Per Week	Weeks Offered	% of Credit Allocated
Lecture	50	3	15	100%
Recitation				
Presentation				
Laboratory				
Lab Prep				
Studio				
Distance				
Clinic				
Experiential				
Research				
Ind. Study				
Pract/Observ				

Cross-Listed Courses

COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):
This course covers topics in and algorithms for visualization: scientific visualization, medical visualization, information visualization, and volume rendering techniques. Fundamental algorithms, advanced techniques, design criteria, and application specific issues will be explored.

*COURSE LEARNING OUTCOMES:
Attached

Calumet Department Head	Date	Calumet School Dean	Date	Calumet Director of Graduate Studies	Date
Fort Wayne Department Head	Date	Fort Wayne School Dean	Date	Fort Wayne Director of Graduate Studies	Date
Indianapolis Department Head	Date	Indianapolis School Dean	Date	IUPUI Associate Dean for Graduate Education	Date
North Central Department Head	Date	North Central School Dean	Date	North Central Director of Graduate Studies	Date
M.R. Melloch	10/5/17				
West Lafayette Department Head	Date	West Lafayette College/School Dean	Date	Date Approved by Graduate Council	Date
Graduate Area Committee Convener	Date	Graduate Dean	Date	Graduate Council Secretary	Date
				West Lafayette Registrar	Date

OFFICE OF THE REGISTRAR

Learning Outcomes –ECE 50834 Visualization Techniques

i. an understanding of the design issues for creating effective visualizations (a)
ii. an ability to apply visualization techniques to an actual visualization problem and associated dataset. (a, b)
iii. an ability to read, evaluate, and present technical papers (b, c)
iv. an understanding of scalar, volume, and surface-based visualization techniques (a)
v. an understanding of the issues and techniques for applying visualization to one of the following visualization problems: medical, flow, scientific, and information (abstract data) (a, c)
vi. an ability to design an effective visualization solution for a problem (c, d)
vii. an ability to present their design and resulting system (c)

Supporting Document to the Form 40G
for a New Graduate Course

To: Purdue University Graduate Council

From: Faculty Member: David Ebert

Department: Electrical and Computer Engineering

Campus: West Lafayette

Date: September 28, 2017

Subject: Proposal for New Graduate Course

Contact for information if questions arise:
Name: Matt Golden
Phone: 494-3374
Email: goldenm@purdue.edu
Address: EE Building, Room 135

Course Subject Abbreviation and Number: ECE 50834

Course Title: Visualization Techniques

Course Description:

This course covers topics in and algorithms for visualization: scientific visualization, medical visualization, information visualization, and volume rendering techniques. Fundamental algorithms, advanced techniques, design criteria, and application specific issues will be explored.

Semesters Offered:

For the benefit of graduate student plan of study development, how frequently will this prototype be offered? Which semesters?
Fall Even Years

A. Justification for the Course:

Visualization has become a fundamental tool for engineering and science. This

course will prepare computer engineering students, as well as engineering and science students to effectively use, evaluate, design, and develop visualizations and visualization software. Computer graphics and visualization are important, fundamental components of modern computer engineering. Therefore, we need this course to educate our students on the basic algorithms, techniques, and tools of this field.

Use the following criteria:
Graduate Council policy requires that courses at the 50000 level in the Purdue system should be taught at the graduate level and meet four criteria: a) the use of primary literature in conjunction with advanced secondary sources (i.e., advanced textbooks); b) assessments that demonstrate synthesis of concepts and ideas by students; c) demonstrations that topics are current, and; d) components that emphasize research approaches/methods or discovery efforts in the course content area (reading the research, critiquing articles, proposing research, performing research). Such courses should be taught so that undergraduate students are expected to rise to the level of graduate work and be assessed in the same manner as the graduate students.

- Anticipated enrollment
  - Undergraduate 2-5
  - Graduate 10-20

B. Learning Outcomes and Method of Evaluation or Assessment:

ECE Graduate Learning Outcomes:

a. Knowledge and Scholarship (thesis/non-thesis)
b. Communication (thesis/non-thesis)
c. Critical Thinking (thesis/non-thesis)
d. Ethical and Responsible Research (thesis) or Professional and Ethical Responsibility (non-thesis)

i. an understanding of the design issues for creating effective visualizations (a)
ii. an ability to apply visualization techniques to an actual visualization problem and associated dataset. (a, b)
iii. an ability to read, evaluate, and present technical papers (b, c)
iv. an understanding of scalar, volume, and surface-based visualization techniques (a)
v. an understanding of the issues and techniques for applying visualization to one of the following visualization problems: medical, flow, scientific, and information (abstract data) (a, c)
vi. an ability to design an effective visualization solution for a problem

(c, d)

VIL an ability to present their design and resulting system ©

- Methods of Instruction

  - Lecture
  - Projects

- Will/can this course be offered via Distance Learning?

  - The course will not be offered via Distance Learning.

- Grading Criteria

Grading criteria (select from checklist); include a statement describing the criteria that will be used to assess students and how the final grade will be determined. Add and delete rows as needed.

  - papers and/or projects
  - attendance/participation

Describe the criteria that will be used to assess students and how the final grade will be determined:

- Paper reading and evaluation - 15%
- Initial visualization assignment - 15%
- Paper presentations and class participation - 15%
- Class project - 55%

C. Prerequisite(s):

List prerequisites and/or experiences/background required. If no prerequisites are indicated, provide an explanation for their absence. Add bullets as needed.

- Graduate standing
- ECE 36800, ECE 36900 (or equivalent)

Prerequisite by Topic: Programming, Data Structures; Discrete Math

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? (If the answer is no, indicate when it is expected that a request will be submitted.) Add rows as needed.

Name	Rank	Dept.	Graduate Faculty or expected date
David Ebert	Professor	ECEN	Yes

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 of 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. **(This information must be listed and may be copied from syllabus).**

Weeks	Principle Topics
1	Introduction to visualization and course assignments and material
1	Fundamental graphics techniques, OpenGL, PC graphics capabilities
1	Data characteristics and scalar techniques
2	Volume visualization algorithms and latest techniques
1	Fundamentals of perception
1	Visualization design principles and illustration-based techniques
2	Flow visualization algorithms and acceleration
2	Medical visualization algorithms, accuracy, assessment, application, latest advances
2	Information visualization techniques and applications
1	Advanced display techniques and virtual reality
1	Project results

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.

- Primary Reading List
    - No official text book.
- Secondary Reading List
    - *The Visualization Handbook*, by Charles Hansen and Christopher Johnson, Academic Press, 2005
    - *Illuminating the Path: The R&D Agenda for Visual Analytics*, Editors: James J. Thomas and Kristin A. Cook (online version)
    - *The Visualization Toolkit: An Object-Oriented Approach to 3D Graphics*, by William Schroeder, Ken Martin, Bill Lorensen, 2nd Edition, 1997, (ISBN 0-13-954694-4).
    - *Readings in Information Visualization: Using Vision to Think*, by Stuart K. Card, Jock D. Mackinlay, and Ben Shneiderman, Morgan Kaufmann
    - *Information Visualization*, Robert Spence, Addison-Wesley

G. Library Resources

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

H. 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 Program.*
See Appendix K.
http://www.purdue.edu/gradschool/faculty/documents/Graduate_School_Policies_and_Procedures_Manual.pdf

ECE 595-003: Visualization Techniques

Introduction

Visualization is the graphical representation of data to aid understanding, and is the key to analyzing massive amounts of data for fields such as science, engineering, medicine, and the humanities. In this course, intended for graduate and advanced undergraduate students, you will learn how to apply these exciting techniques to practical problems and work on state-of-the-art research projects that could lead to a publication in one of the prestigious IEEE VisWeek conferences!

This course will serve as an introduction to the science and technology of visualization. The course contents will include both theoretical foundations of this interdisciplinary science as well as practical applications of integrated visualization techniques on real-world problems.

Course Website

http://pixel.ecn.purdue.edu:8080/~amalik/ECE595_Fall2014/

Overview

This course will cover topics in visualization such as scientific visualization, medical visualization, and information visualization. The format for the course will be group discussions of papers, some lectures by the instructor, and some student presentations of papers. The grading will be based on participation in class, critical assignments, and class projects. Class projects may be done individually or in groups. Projects have the potential of leading to work that forms the basis of an undergraduate research project, Master's thesis, or Ph.D. research topic.

Instructors

Dr. David Ebert

- Office: POTR 228
- Office hours: Fri 1:30pm – 2:30pm
- Email: ebertd@purdue.edu

Dr. Abish Malik

- Office: TBD
- Office hours: TBD
- Email: amalik@purdue.edu

Readings

There is no official textbook for this course. Students will read and discuss seminal and current technical research papers. A list of readings (in progress and subject to frequent update) is available on the course website.

The following books may be useful as references.

- *The Visualization Handbook*, by Charles Hansen and Christopher Johnson, Academic Press, 2005
- *Illuminating the Path: The R&D Agenda for Visual Analytics*, Editors: James J. Thomas and Kristin A. Cook (online version)
- *The Visualization Toolkit: An Object-Oriented Approach to 3D Graphics*, by William Schroeder, Ken Martin, Bill Lorensen, 2nd Edition, 1997, (ISBN 0-13-954694-4).
- *Readings in Information Visualization: Using Vision to Think*, by Stuart K. Card, Jock D. Mackinlay, and Ben Shneiderman, Morgan Kaufmann
- *Information Visualization*, Robert Spence, Addison-Wesley

Assessment Methods

The course outcomes will be assessed through student demonstration of a completed visualization project, submission of working program(s), oral and written presentation of results (literature survey, alpha release report, beta release report, regular meetings of project teams with the instructor, and the final project report). The overall knowledge acquisition of visualization techniques will be assessed by student oral presentations of papers, through the completion of a literature review, and through several initial project assignments.

Academic Integrity

Students must conform to Purdue's policy on academic integrity. More specifically, Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [University Regulations, Part 5, Section III, B, 2, a]

Here is a non-exhaustive list of examples of dishonest behavior:

- Sharing results or information during exams
- Bringing forbidden material or devices to exam
- Working on exam after official time limit
- Collaborating on assignments
- Submitting work that is not yours
- Copying text from existing sources without properly referencing it

In particular, this includes **copying** text from research papers you are summarizing, unless you properly quote and cite the text you copied. If you copy text from existing papers and try to pass this off as your own, you are committing **severe plagiarism** and you will have to face the consequences.

Note that class projects may involve several students, in which case collaboration and sharing between project members naturally is allowed.

For more information, see Purdue's online brochure on academic integrity:http://www.purdue.edu/odos/osrr/academicintegritybrochure.php

Cheating or otherwise abusing academic integrity (at the discretion of the instructors) will at the minimum result in a zero grade for the assignment or exam, and will likely result in a failing grade for the whole course. The instructors will also initiate disciplinary actions with Purdue.

Campus 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. In such an event, information will be provided through Blackboard Learn and through the course website.

Detailed Schedule (Tentative)

Week 1 (Aug. 25-31):
- Monday – Course Organization
- Wednesday – Assignment
- Friday – Introduction to Visualization

Week 2 (Sept. 1-7):
- Monday – **Labor Day holiday – No Class**
- Wednesday – Open Research Questions in Visualization
- Friday – Color, Perception, Cognition
  - *VisualRepresentations assignment due*

Week 3 (Sept. 8-14):
- Monday – Discussion of the VisualRepresentations assignment
- Wednesday – Graphics for Visualization
- Friday – **Presentations** (*Course Project: Proposals*)

Week 4 (Sept. 15-21):
- Monday – Data Models
- Wednesday – Multidimensional Visualization
- Friday – **Presentations** (Paper presentations)

Week 5 (Sept. 22-28):
- Monday – Graphs and Trees I
- Wednesday – Graphs and Trees II
- Friday – **Presentations** (Paper presentations)
- Sunday – *Course Project: Literature review due*

Week 6 (Sept. 29-Oct. 5):
- Monday – Time
- Wednesday – Text
- Friday – **Presentations** (Paper presentations)
- Sunday – *Course Project: Design document due*

Week 7 (Oct. 6-12):
- Monday – Space
- Wednesday – Interaction
- Friday – **Presentations** (Paper presentations)

Week 8 (Oct. 13-19):
- Monday – **Fall Break – No Class**
- Wednesday – **Guest Lecture - TBD**
- Friday – Animation
- Sunday – *Course Project: Alpha release due*

Week 9 (Oct. 20-26):
- Monday – Collaboration
- Wednesday – Visualization on the Web

Friday – **Presentations** (Paper presentations)

Week 10 (Oct. 27–Nov. 2):

Monday – Visualization for Mobile Devices, Large Displays, and Ubiquitous Computing

Wednesday – Visualization Design and Principles

Friday – **Presentations** (Paper presentations)

Week 11 (Nov. 3-9):

Monday – Visual Analytics

Wednesday – Spatiotemporal Visualization

Friday – **Presentations** (Paper presentations)

Week 12 (Nov. 10-16):

Monday – **VisWeek**

Wednesday – **VisWeek**

Friday – **Presentations** (Paper presentations)

Sunday – *Course Project: Beta release due*

Week 13 (Nov. 17-23):

Monday – HCI

Wednesday – Perception

Friday – **Presentations** (Paper presentations)

Sunday – *Course Project: Paper draft due (optional)*

Week 14 (Nov. 24-30):

Monday – Production, Presentation, Dissemination

Wednesday – **Thanksgiving Break – No Class**

Friday – **Thanksgiving Break – No Class**

Sunday – *Course Project: Final paper due*

Week 15 (Dec. 1-7):

Monday – Conducting Research in Visualization and Visual Analytics

Wednesday – **Presentations** (Paper presentations)

Friday – **Presentations** (Paper presentations)

Course Project: Final Release

Paper Reviews due

Week 16 (Dec. 8-12):

Monday – **Project Presentations I**

Wednesday – **Project Presentations II**

Friday – **Project Presentations III**

Grades

Grades will be assigned on the following grounds:

- Paper reading and evaluation - 15%
- Initial visualization assignment - 15%
- Paper presentations and class participation - 15%
- Class project - 55%

Phases may be turned in up to one week after the due date with a 30% grade penalty. Phases will not be accepted more than a week late. Plus/minus grading will be used in this class.

Class Project Grading:

Activity	Deadline	Grade %
Project Proposal	September 14	5
Literature Review	September 28	5
Design	October 5	5
Alpha Release	October 19	5
Beta Release	November 16	5
Paper Draft (Optional)	November 23	--
Paper	November 30	10
Final Release	December 7	10
Reviews	December 7	5
Presentation	Mon/Wed/Fri	5
Total Grades for Project		55

Course Project

Details on the course project are available here.

Paper Summaries

Details on the paper summaries are available here.