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.

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

☐ 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

PROPOSED:

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

EXISTING:

Subject Abbreviation:
Course Number:

TERMS OFFERED:

Check All That Apply:
☑ Fall  ☑ Spring  ☑ Summer

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

CREDIT TYPE

1. Fixed Credit: Cr. Hrs: 3.0
2. Variable Credit Range: Minimum Cr. Hrs
(Choose One) To Cr
Maximum Cr. Hrs
3. Equivalent Credit: Yes ☐ No ☐
4. Thesis Credit: Yes ☐ No ☐

COURSE ATTRIBUTES: Check At That Apply

1. Pass/No Pass Only
2. Satisfactory/Unsatisfactory Only
3. Repeatable
4. Maximum Repeatable Credit:
5. Fees ☑ Coop ☑ Lab ☑ Rate Request ☑
6. Registration Approval Type
7. Variable Title
8. Honors
9. Credit by Examination
10. Full Time Privilege
11. Off Campus Experience
Include comment to explain fees

Schedule Type    Minutes    Meetings Per    Weeks    % of Credit
Lecture          Per Mtg     Week 15            Offered    Cross-Listed Courses
Presentation
Laboratory
Lab Prep
Study
Distance
Clinic
Experiential
Research
Ind. Study
Prad/Observ

COURSE DESCRIPTION (INCLUDE REQUIREMENTS/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

Indiana 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

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)
vi. 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)

VI. 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.

<table>
<thead>
<tr>
<th>Name</th>
<th>Rank</th>
<th>Dept.</th>
<th>Graduate Faculty or expected date</th>
</tr>
</thead>
<tbody>
<tr>
<td>David Ebert</td>
<td>Professor</td>
<td>ECEN</td>
<td>Yes</td>
</tr>
</tbody>
</table>

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

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

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
  - Illuminating the Path: The R&D Agenda for Visual Analytics, Editors: James J. Thomas and Kristin A. Cook (online version)
  - 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.

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)
• 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 Perception
- Wednesday – **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:

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

Course Project

Details on the course project are available here.

Paper Summaries

Details on the paper summaries are available here.