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 61016 Power Electronic Converters & Systems

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 61016  Power Electronic Converters & Systems
Sem. 1, Lecture 3, Cr. 3.

Prerequisite: ECE 202 and PHYS 272
Prerequisite by Topic: Basic circuit analysis; elementary electromagnetics; elementary mechanics

Description: The objective of this course is to educate students in the operation, detailed modeling, average-value modeling, and control design of power electronics converters and systems of converters.

Reason: Power electronics is a key discipline within power engineering. It is one of the bases of hybrid electric vehicles, electric vehicles, wind and PV power generation, dc transmission systems, flexible ac transmission systems, electric drive and propulsion systems, and almost all mobile power systems. This course is the primary graduate level course concerning power electronics within the ECE curriculum at Purdue. It is taught from a rigorous mathematical perspective from a graduate level textbook, papers, and supplementary notes. Although the course normally includes midterm and final exams, the assessment for the course is dominated by course projects with a research flavor. The course is not appropriate for undergraduates.

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

Approved for the faculty of the Schools of Engineering by the Engineering Curriculum Committee
ECC Minutes 11-15-16
Chairman ECC
PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF A GRADUATE COURSE
(50000-60000 LEVEL)

DEPARTMENT: Electrical and Computer Engineering  EFFECTIVE SESSION: Spring 2016

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

- New course with supporting documents (complete proposal form)
- Add existing course offered at another campus
- Expiration of a course
- Change in course number
- Change in course title
- Change in course credit type
- Change in course attributes
- Change in instructional hours
- Change in course description
- Change in course requisites
- Change in semesters offered
- Transfer from one department to another
- CAMPUS(ES) INVOLVED
  - Calumet
  - N. Central
  - Cont Ed
  - Tech Statewide
  - Ft. Wayne
  - W. Lafayette
  - Indianapolis

PROPOSED:
- Subject Abbreviation: ECE
- Course Number: 61016
- Long Title: Power Electronic Converters & Systems
- Short Title: Power Electronic Conv. & Sys

EXISTING:
- Subject Abbreviation:
- Course Number:
- Long Title:
- Short Title:

TERMS OFFERED:
- Check All That Apply:
  - Fall
  - Spring
  - Summer

COURSE ATTRIBUTES:
- Check All That Apply:
  - Course Approval Type
  - Department
  - Instructor
  - Credit by Examination
  - Full Time Privilege
  - Off Campus Experience

COURSE DESCRIPTION (INCLUDE REQUIREMENTS/RESTRICTIONS):
The objective of this course is to educate students in the operation, detailed modeling, average-value modeling, and control design of power electronics converters and systems of converters.

COURSE LEARNING OUTCOMES:
- Understanding of switched circuits (a,c)
- Understanding of average-value analysis techniques (a,c)
- Understanding of feedforward/feedback control of power electronic converters (a,c)

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

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

OFFICE OF THE REGISTRAR
Supporting Document to the Form 40G
for a New Graduate Course

To: Purdue University Graduate Council

From: Faculty Member: Scott Sudhoff

Department: Electrical and Computer Engineering
Campus: West Lafayette

Date:

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 61016

Course Title: Power Electronic Converters & Systems

Course Description:
The objective of this course is to educate students in the operation, detailed modeling, average-value modeling, and control design of power electronics converters and systems of converters.

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:

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 (500- or 600-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.

Power electronics is a key discipline within power engineering. It is one of the bases of hybrid electric vehicles, electric vehicles, wind and PV power generation, dc transmission systems, flexible ac transmission systems, electric drive and propulsion systems, and almost all mobile power systems. This course is the primary graduate level course concerning power electronics within the ECE curriculum at Purdue. It is taught from a rigorous mathematical perspective from a graduate level textbook, papers, and supplementary notes. Although the course normally includes midterm and final exams, the assessment for the course is dominated by course projects with a research flavor. The course is not appropriate for undergraduates.

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  0
  - Graduate  20-30

**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)
• List Learning Objectives for this course and map each Learning Objective to one or more of the ECE Learning Outcomes (a-d, listed above):
  
  a. Understanding of switched circuits (a,c)
  b. Understanding of average-value analysis techniques (a,c)
  c. Understanding of feedforward/feedback control of power electronic converters (a,c)
  d. Understanding of waveform level and average-value simulation techniques for switched systems (a,c)
  e. Understanding of several ac-dc, dc-ac, and dc-dc power conversion topologies (a,c)
  f. Understanding of inverter modulation techniques (a,c)
  g. Understanding of ethical homework and project practices, and implications of failure to adhere to these (d)
  h. Understanding of how to effectively present project results (b)

• Methods of Instruction
  
  o Lecture

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

  This course is offered through 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.
  
  o exams
  o projects

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

  The final grade is dominated by the performance of the projects, which generally accounts for 70% of the final grade. The midterm and final exam are often weighted at 15% each.

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 or Consent of Instructor
• Prerequisite by Topic: Basic knowledge of ordinary differential equations, solution of ODEs using numerical methods, state-space system representation, basic feedback control design with frequency domain methods, reference frame theory, some knowledge of rotating electric machinery

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>
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<tbody>
<tr>
<td>Scott Sudhoff</td>
<td>Professor</td>
<td>ECEN</td>
<td>Yes</td>
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</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>Principal Topics</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td><strong>Basic Tools</strong></td>
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<tr>
<td></td>
<td>GOSET for Single and Multi-Objective Optimization</td>
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<td>Simulink for Time-Domain Simulation</td>
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<tr>
<td>2</td>
<td><strong>DC-DC Conversion</strong></td>
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<td>Buck Converters</td>
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<td>Waveform-Level Modeling</td>
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<td>Average-Value Modeling</td>
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<td>Control Design Case Study</td>
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<td>4</td>
<td><strong>Controlled DC-AC and AC-DC Conversion</strong></td>
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<td></td>
<td>The Three-Phase Bridge Inverter</td>
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<td></td>
<td>Waveform-Level Modeling</td>
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<td>Average-Value Modeling</td>
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<td>Control Design Case Study: Ship Service Inverter Module</td>
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<td>Review of Permanent Magnet AC Machine</td>
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<td>Control Design Case Study: PMAC DC Generation System</td>
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<td>3</td>
<td><strong>Uncontrolled AC-DC and DC-AC Conversion</strong></td>
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<td>Line-Commutated Converters (LCCs)</td>
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<td>Operation of LCCs from Ideal Source</td>
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<td>Waveform Level Modeling of LCCs</td>
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<td></td>
<td>Average-Value Modeling of LCCs</td>
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<td>Synchronous Machine LCC Systems</td>
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<td>3</td>
<td><strong>Special Topics (At Discretion of Class/Instructor)</strong></td>
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<td></td>
<td>Isolating DC/DC Converters</td>
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<td>Multi-level Converters</td>
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<td>Immittance Based Stability Methods</td>
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<td>Soft Switched and Resonant Converters</td>
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<td></td>
<td>Common Mode Effects</td>
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<td>1</td>
<td><strong>Exams</strong></td>
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</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**
  

- **Secondary Reading List**
  
  
  
  
  - S.H. Zak, *Systems and Control*, Oxford University Press, 2003 (Chapter 4)
  
  
  - Sudhoff, GOSET Manual, Version 2.2

**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.