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**REQUEST FOR CORE ORAL INTENSIVE DESIGNATOR**

**SUBMITTED BY:**

Department	<b>Electrical &amp; Comp Engr</b>	College/School	<b>CEM</b>
Prepared by	<b>Richard Wies</b>	Phone	<b>474-7071</b>
Email Contact	<b>rwwiesjr@alaska.edu</b>	Faculty Contact	<b>Richard Wies</b>

See <http://www.uaf.edu/uafgov/faculty/cd> for a complete description of the rules governing curriculum & course changes.

**1. COURSE IDENTIFICATION:**

Dept	<b>EE</b>	Course #	<b>408</b>	No. of Credits	<b>3(3+0); 4(3+3) with approved course change</b>
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<b>COURSE TITLE</b>	<b>Power Electronics; Power Electronics Design with approved course change.</b>
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Existing Course	X (with approved course change)	New Course Pending Approval*	
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\*Must be approved by appropriate Curriculum Council.)

**2. EMPHASIS DESIRED:** (See Guidelines for Oral Intensive Designator)

Group (medium or large class)	
Public (medium or large class)	
Public (small class)	x
Public (large class) "O/2"	

**3. CURRENT CATALOG DESCRIPTION AS IT APPEARS IN THE CATALOG:** including dept., number, title and credits

**EE F408 Power Electronics Design**  
3 Credits Offered Spring  
Study of past and current technology used in power conversion and control equipment. Topics will include the theory and application of thyristors, rectifiers, DC-DC converters, inverters, resonant converters, AC and DC switches and regulators, power supplies, DC drives, and adjustable-speed drives including variable-frequency drives and cycloconverters. *Prerequisites: EE F303; EE F333; or permission of instructor.* Stacked with EE F608. (3+0)

**JUSTIFICATION FOR ACTION REQUESTED**

The purpose of the department and campus-wide curriculum committees is to scrutinize course designator applications to make sure that the quality of UAF education is not lowered as a result of the proposed change. Please address this in your response. This section needs to be self-explanatory. Use as much space as needed to fully justify the proposed change and explain what has been done to ensure that the quality of the course is not compromised as a result.

A course in power electronics design is needed to supplement the electrical engineering undergraduate senior design elective requirements for the power and controls option. The lecture portion of this course is similar to the current EE 408/608: Power Electronics course. The proposed course change adds a SENIOR DESIGN ELECTIVE component through the addition of a laboratory and senior design project which SATISFIES the ORAL INTENSIVE COURSE REQUIREMENT through 3 oral project presentations (2-15 minute: proposal and midterm progress and 1-20 minute: final with 5 minute Q&A) that comprise 15% of the final course grade.

Please see the attached syllabus and senior design project description for a detailed outline of the ORAL intensive course requirements and grade distribution. This course was offered as a special topics course in the Spring 2011.

The attached syllabus must clearly reflect the following basic elements for the **ORAL COMMUNICATION** emphasis requested. Please note them directly on the syllabus, using the corresponding letter. (See Guidelines in this manual.)

**GROUP (medium or large class)** (Regularly enrolling at least 12 students)

- A 15% of the final grade based on oral communication
- B 1 ongoing, integrated group project with 5-8 students
- C 2 presentations (minimum of 5 minutes per member)
- D Question & Answer period for both presentations
- E Group and Individual grading
- F Instructor Evaluation/Feedback on all presentations

**PUBLIC (medium or large class)** (Regularly enrolling at least 12 students)

- A 15% of the final grade based on oral communication
- B 3 presentations (minimum of 5 minutes each)
- C Question & Answer period for both presentations
- D Instructor Evaluation/Feedback on all presentations


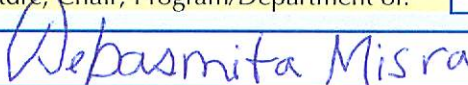
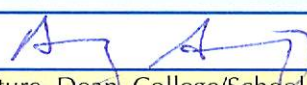
**PUBLIC (small class)** (Regularly enrolling less than 12 students)

- A 15% of the final grade based on oral communication
- B 2 presentations of 20 minutes with Question & Answer **or**  
3 presentations of 10 minutes with Question & Answer
- C Instructor Evaluation/Feedback on all presentations

**PUBLIC (large class) "O/2"** (Regularly enrolling 20 or more students)

- A 7.5% of the final grade based on oral communication
- B 1 presentation (minimum of 5 minutes), **and**
- C 1 presentation of 8-10 minutes with Question & Answer
- D Instructor Evaluation/Feedback on all presentations

**APPROVALS:**

 Signature, Chair, Program/Department of:	Date	9/27/11
ECE		
 Signature, Chair, College/School Curriculum Council for:	Date	9/30/11
 Signature, Dean, College/School of:	Date	11/3/11
CEM		

**ALL SIGNATURES MUST BE OBTAINED PRIOR TO SUBMISSION TO THE GOVERNANCE OFFICE**

_____ Signature, Chair, Senate Core Review Committee	Date	_____
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**ATTACH COMPLETE SYLLABUS (as part of this application).**

Note: The guidelines are online: <http://www.uaf.edu/uafgov/faculty/cd/syllabus.html>

The department and campus wide curriculum committees will review the syllabus to ensure that each of the items listed below are included. If items are missing or unclear, the proposed course change will be denied.

**SYLLABUS CHECKLIST FOR ALL UAF COURSES**

During the first week of class, instructors will distribute a course syllabus. Although modifications may be made throughout the semester, this document will contain the following information (as applicable to the discipline):

**1. Course information:**

Title,  number,  credits,  prerequisites,  location,  meeting time  
(make sure that contact hours are in line with credits).

**2. Instructor (and if applicable, Teaching Assistant) information:**

Name,  office location,  office hours,  telephone,  email address.

**3. Course readings/materials:**

Course textbook title,  author,  edition/publisher.  
 Supplementary readings (indicate whether  required or  recommended) and  
 any supplies required.

**4. Course description:**

Content of the course and how it fits into the broader curriculum;  
 Expected proficiencies required to undertake the course, if applicable.  
 Inclusion of catalog description is *strongly* recommended, and  
 Description in syllabus must be consistent with catalog course description.

**5.  Course Goals (general), and (see #6)**

**6.  Student Learning Outcomes (more specific)**

**7. Instructional methods:**

Describe the teaching techniques (eg: lecture, case study, small group discussion, private instruction, studio instruction, values clarification, games, journal writing, use of Blackboard, audio/video conferencing, etc.).

**8. Course calendar:**

A schedule of class topics and assignments must be included. Be specific so that it is clear that the instructor has thought this through and will not be making it up on the fly (e.g. it is not adequate to say "lab". Instead, give each lab a title that describes its content). You may call the outline Tentative or Work in Progress to allow for modifications during the semester.

**9. Course policies:**

Specify course rules, including your policies on attendance, tardiness, class participation, make-up exams, and plagiarism/academic integrity.

**10. Evaluation:**

Specify how students will be evaluated,  what factors will be included,  their relative value, and  
 how they will be tabulated into grades (on a curve, absolute scores, etc.)

**11. Support Services:**

Describe the student support services such as tutoring (local and/or regional) appropriate for the course.

**12. Disabilities Services:**

The Office of Disability Services implements the Americans with Disabilities Act (ADA), and insures that UAF students have equal access to the campus and course materials.

State that you will work with the Office of Disabilities Services (208 WHIT, 474-5655) to provide reasonable accommodation to students with disabilities."

**University of Alaska Fairbanks**  
**Electrical and Computer Engineering Department**  
**EE 408/608 - Power Electronics Design**  
**Spring 2012**

**Course Information:**

Title: EE 408/608 Power Electronics Design (3+3)  
Lecture Time: MWF (11:45AM-12:45PM) in Duckering 202  
Lab Time: M (2:15-5:15PM) in Duckering 202, Duckering 330, and Duckering 216  
Prerequisites: COMM F131X or COMM F141X; EE 303; EE 334; EE 354; ENGL F111X;  
ENGL F211X or ENGL 213X or permission of instructor; senior standing

**Instructor:** Dr. Richard Wies, Associate Professor, ECE Dept.  
**Office:** Duckering 213  
**Office Hours:** W 2-3PM, TR 11AM-12PM or by phone/e-mail  
**Phone:** 474-7071  
**E-mail:** rwwiesjr@alaska.edu

**Required Text:** Mohan, Undeland, and Robbins, Power Electronics: Converters, Applications, and Design, 3<sup>rd</sup> ed., Wiley, 2003.

**References:** Daniel W. Hart, Power Electronics, McGraw-Hill, 2011.

**Course Description:** Analysis and design of power electronic conversion, control and drive systems with emphasis on smart grid applications. Topics will include the theory and application of thyristors, rectifiers, DC-DC converters, inverters, resonant converters, AC and DC switches and regulators, power supplies, DC drives, and adjustable-speed drives. Includes laboratory exercises using power electronic converter boards and a complete power electronics design project.

**Course Goals:** Students will develop an understanding of power electronic conversion, control and drive systems with emphasis on analysis and design concepts. The course will develop the building blocks for power electronic devices including rectifiers, inverters, and converters. Analysis will include the use of PSPICE and the use of Fourier transforms for harmonics. Design will include a project to build an operational power electronic conversion device.

**Instruction Methods:** Application of fundamental circuit and electronic principles, including time domain and Fourier analysis, in the analysis, design and operation of power electronic devices.

**Evaluation/Grading:** Plus/Minus grading will be used – see page 48 of the 2011-2012 UAF catalog for numerical values. Grades will be assigned based on absolute scores.

Written and Oral Intensive Course (W/O) Requirements: EE 4/608 Power Electronic Design is a writing and oral intensive course and according to university regulations 50% of the course grade must be based on written work and 15% of the course grade must be based on oral presentations. The grade for written assignments will be based on content, English usage, organization and format. Content refers to the effectiveness of the report in communicating the technical aspects of the assignment. English usage refers to punctuation, spelling, sentence structure, etc. Organization refers to how logically the sentences, paragraphs and body of the report are organized. Format refers to how well the report conforms to the required report formatting guidelines. A personal interview with each student will follow the completion of the rough draft of the final report to provide feedback for refinement of the final report.

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Oral presentations will be graded according to content, voice, use of visual aides and format. There will be three presentations of at least 10 minutes each and one impromptu presentation. Each presentation will be followed by a brief question and answer period and instructor evaluation.

The percentages in the following grading criteria are based on the total points possible (1000) in the course.

<b>Exam I</b>	<b>75 (7.5%)</b>
<b>Exam II</b>	<b>75 (7.5%)</b>
<b>Written/Oral</b>	
<b>Written</b>	<b>500 (50%)</b>
<b>Project Reports</b>	
<b>Proposal</b>	<b>5%</b>
<b>Mid Term Progress</b>	<b>5%</b>
<b>Draft Report</b>	<b>15%</b>
<b>Final Report</b>	<b>10%</b>
<b>Lab Reports</b>	<b>15%</b>
<b>Oral Presentations</b>	<b>150 (15%)</b>
<b>Proposal</b>	<b>3%</b>
<b>Mid Term Progress</b>	<b>3%</b>
<b>Final</b>	<b>9%</b>
<b>Project Performance</b>	<b>150 (15%)</b>
<b><u>Homework</u></b>	<b><u>50 ( 5%)</u></b>
<b>Total</b>	<b>1000(100%)</b>

**408 vs 608:** Students enrolled in 608 will be required to complete a design project that involves 2 times the workload for the undergraduates. Graduate students will also be required to complete more difficult questions on exams and homework. The questions will be optional for undergraduate students who may complete them for extra credit.

**Course Schedule/Senior Design Components:**

The course schedule attached to this syllabus provides topics for each lecture and laboratory. Note that a significant portion of the laboratory is centered around the senior design project. The specific design project components of the lecture and laboratory in this course are **highlighted in green** in the schedule, including a proposal, three project reports, three oral presentations, and project demonstrations (performance). A senior project design requirement and specification handout will be provided during the first laboratory session.

**Course Policies:**

**Homework:** Homework will be assigned on a weekly basis and is due at the beginning of class on the due date. No late homework will be accepted unless previously authorized by the instructor. I encourage discussion of solution techniques with your fellow students, but you must independently formulate your results. Some homework assignments will include computer-aided simulation and analysis of power electronic devices and systems. Homework solutions will be posted on Blackboard within a few days after the assignments are due.

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**Exams:** Midterm exams are open book and closed notes with *two* 8.5x11 (INCHES) formula sheets allowed. Formula sheets cannot have solved problems and must be attached to the exam. **Laptops, cell phones, and calculators with communication capability (Bluetooth, etc.) are not permitted to be used during the exams.** Absences from exams must be preceded by a valid excuse. In the event of a valid excused absence it is the student's responsibility to contact the instructor to arrange for a make-up exam.

**Cheating/Plagiarism:** Cheating and plagiarism will not be tolerated and will result in failure of the course.

**Attendance:** As directly quoted from the 2011-2012 UAF Course Catalog under Academics/Attendance (page 48):

“You are expected to attend class regularly; unexcused absences may result in a failing grade. You are responsible for conferring with your instructor concerning absences and the possibility of arranging to make up missed work....However, your instructor is under no obligation to allow you to make up missed work for unexcused absences or if notification and arrangements are not made in advance of the absence.”

**Disabilities Services:** The Office of Disability Services implements the Americans with Disabilities Act (ADA), and insures that UAF students have equal access to the campus and course materials. The instructor, the teaching assistant, and the administrative assistant will work with the Office of Disabilities Services to provide reasonable accommodation to students with disabilities. Disability Services is located at the Center for Health and Counseling in 203 WHIT. The coordinator of Disability Services can be contacted by phone at 474-7043 or 474-7045 (TTY), and by email at [fydso@uaf.edu](mailto:fydso@uaf.edu).

**Student Learning Outcomes:**

The B.S.E.E. program at UAF is accredited by the Accreditation Board for Engineering and Technology (ABET). Accreditation requires that all students graduating from this program must achieve the following Program Outcomes. This course addresses the Program Outcomes indicated below in bold:

- (a) **an ability to apply knowledge of mathematics, science, and engineering**
- (b) **an ability to design and conduct experiments, as well as to analyze and interpret data**
- (c) **an ability to design a system, component, or process to meet desired needs**
- (d) **an ability to function on multi-disciplinary teams**
- (e) **an ability to identify, formulate, and solve engineering problems**
- (f) **an understanding of professional and ethical responsibility**
- (g) **an ability to communicate effectively**
- (h) **the broad education necessary to understand the impact of engineering solutions in a global and societal context**
- (i) **a recognition of the need for, and an ability to engage in life-long learning**
- (j) **a knowledge of contemporary issues**
- (k) **an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice**

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**EE 408/608 – Tentative Lecture/Lab Schedule – Spring 2012**

All dates and topics are tentative. Exam dates are subject to change.

MONDAY (LECTURE)	MONDAY (LAB)	WEDNESDAY	FRIDAY
			<b>Jan. 20 – Lecture #1</b> Power Electronics: Introduction; Compared to Linear Electronics; Classification of Power Processors; Convention – Sections 1.1-1.7
<b>Jan. 23 – Lecture #2</b> Semiconductor Switching Devices: Available Types, Characteristics, Functions, Comparison & Future Trends; Snubber Circuits – Sections 2.1-2.11	<b>Jan. 23 – Lab #1</b> <b>Introduction to Project</b> - <b>Project Overview</b> - <b>Presentation Guideline</b> - <b>Project Proposal</b> - <b>Break into Teams</b>	<b>Jan. 25 – Lecture #3</b> Power Concepts: Displacement pf (DPF); Harmonics: Fourier Analysis, Line Current Harmonics, THD, and True PF – Section 3.2.4	<b>Jan. 27 – Lecture #4</b> Inductor & Capacitor Response: Steady-State and Transient Responses – Sections 3.2.5
<b>Jan. 30 – Lecture #5</b> DC-DC Switch Mode Converters: Types; PWM Control; Buck (Step- Down) with Continuous Conduction Mode (CCM) – Sections 7.1-7.3.2	<b>Jan. 30 – Lab #2</b> <b>Introduction to:</b> - <b>PSPICE Power</b> <b>Electronics Tools</b> - <b>Power Pole DC</b> <b>Converter Experiment</b> <b>Boards</b> - <b>TTech J5 Circuit</b> <b>Board Prototyping</b> <b>Machine</b>	<b>Feb. 1 – Lecture #6</b> DC-DC Switch Mode Converters: Buck with & Discontinuous Conduction Mode (DCM); Output Voltage Ripple; Boost (Step-Up) with CCM & DCM – Section 7.3.3-7.4	<b>Feb. 3 – Make-Up Lecture</b>
<b>Feb. 6 – Lecture #7</b> DC-DC Switch Mode Converters: Buck-Boost with CCM & DCM – Section 7.5	<b>Feb. 6 – Lab #3</b> <b>Oral Presentation I:</b> <b>Project Proposal</b> <b>Presentations</b>  – <b>Project Proposals Due</b>	<b>Feb. 8 – Lecture #8</b> DC-DC Switch Mode Converters: Cuk – Section 7.6	<b>Feb. 10 – Lecture #9</b> DC-DC Switch Mode Converters: Full-Bridge (4-quadrant); Bipolar and Unipolar Switching; Voltage Ripple – Section 7.7
<b>Feb. 13 – Lecture #10</b> DC-DC Switch Mode Converters: Comparison using Switch Utilization Factor; Equivalent Circuits; Reversing Power Flow – Sections 7.8	<b>Feb. 13 – Lab #4</b>  <b>DC Converters: Buck,</b> <b>Boost, and Buck-Boost</b> <b>Converter using the</b> <b>Power Pole Board</b>	<b>Feb. 15 – Lecture #11</b> Uncontrolled Diode Rectifiers: Concept using simple R-L Circuit and Back EMF; Single-Phase Diode Bridge Rectifier Circuits with DC Side Current Source – Sections 5.1-5.3	<b>Feb. 17 – Lecture #12</b> Uncontrolled Diode Rectifiers: Single-Phase Diode Bridge Rectifier Circuits with: 1) AC side Inductance and DC Side Current Source 2) AC Side Inductance and DC Side Voltage – Section 5.3

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MONDAY (LECTURE)	MONDAY (LAB)	WEDNESDAY	FRIDAY
<b>Feb. 20 – Lecture #13</b> Uncontrolled Diode Rectifiers: Single-Phase Diode Bridge Rectifier Line Current and Voltage Distortion; Voltage Doubler; Three-Phase, 4-Wire Neutral Current Effects – Sections 5.3-5.5	<b>Feb. 20 – Lab #5</b> <b>DC Converters: Flyback and Forward Converters using the Power Pole Boards</b>	<b>Feb. 22 – Lecture #14</b> Uncontrolled Diode Rectifiers: Three-Phase, Full-Bridge Rectifier – Section 5.6	<b>Feb. 24 – Lecture #15</b> Uncontrolled Diode Rectifiers: Comparison of Single-Phase and Three-Phase; Inrush Current and Overvoltage at Turn-On; Improving Line Current Harmonics and Power Factor – Sections 5.7-5.9
<b>Feb. 27 – Lecture #16</b> Phase-Controlled Rectifiers: Thyristor Circuits – Sections 6.1-6.2	<b>Feb. 27 – Lab #6</b> <b>Switching Characteristics of MOSFETs and DIODES used in DC Converters</b>	<b>Feb. 29 – Review for EXAM #1</b> <b>Ch. 1-4, &amp; 7</b> <b>OPEN BOOK</b> <b>2 Formulas Sheets</b>	<b>Mar. 2 – EXAM #1</b> <b>Ch. 1-4, &amp; 7</b> <b>OPEN BOOK</b> <b>2 Formulas Sheets</b>
<b>Mar. 5 – Lecture #17</b> Phase-Controlled Rectifiers: Ideal Single-Phase Converters – Section 6.3.1	<b>Mar. 5 – Lab #7</b> <b>Voltage and Peak Current Mode Control of DC Converters</b>	<b>Mar. 7 – Lecture #18</b> Phase-Controlled Rectifiers: Single-Phase Converters with Source Inductance – Section 6.3.2	<b>Mar. 9 – Lecture #19</b> Phase-Controlled Rectifiers: Practical Single-Phase Converters and Inverter Mode of Operation – Sections 6.3.3-6.3.4
<b>Mar. 12 – NO CLASS</b> <b>Spring Break</b>	<b>Mar. 12 – NO LAB</b> <b>Spring Break</b>	<b>Mar. 14 – NO CLASS</b> <b>Spring Break</b>	<b>Mar. 16 – NO CLASS</b> <b>Spring Break</b>
<b>Mar. 19 – Lecture #20</b> Phase-Controlled Rectifiers: Ideal Three-Phase Converters – Sections 6.4.1	<b>Mar. 19 – Lab #8</b> <b>Oral Presentation II: Progress Report Presentations</b>  <b>- Project Progress Reports Due</b>	<b>Mar. 21 – Lecture #21</b> Phase-Controlled Rectifiers: Three-Phase Converters with Source Inductance – Sections 6.4.2	<b>Mar. 23 – Lecture #22</b> Phase-Controlled Rectifiers: Practical Three-Phase Converters and Inverter Mode of Operation – Sections 6.4.3-6.4.4
<b>Mar. 26 – Lecture #23</b> Switch-Mode Inverters: Basic Concept, PWM, & Square-Wave Switching – Section 8.2	<b>Mar. 26 – Lab #9</b> <b>Single-Phase Diode Rectifiers: Design and Simulation</b>	<b>Mar. 28 – Lecture #24</b> Switch-Mode Inverters: Single-Phase Half-Bridge; Full-Bridge with Bipolar Switching – Sections 8.3.1-8.3.2.1	<b>Mar. 30 – Lecture #25</b> Switch-Mode Inverters: Single-Phase Full-Bridge with Unipolar Switching & Square Wave Mode of Operation – Sections 8.3.2.2-8.3.2.3



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MONDAY (LECTURE)	MONDAY (LAB)	WEDNESDAY	FRIDAY
<b>Apr. 2 – Lecture #26</b> Switch-Mode Inverters: Single-Phase Full-Bridge with Voltage Cancellation; Switch Utilization; Voltage Output Ripple – Sections 8.3.2.4-8.3.2.6	<b>Apr. 2 – Lab #10</b> <b>Design Project Time</b>	<b>Apr. 4 – Lecture #27</b> Switch-Mode Inverters: Push-Pull Inverters; Switch Utilization – Sections 8.3.3-8.3.4	<b>Apr. 6 – Lecture #28</b> Switch-Mode Inverters: Three-Phase Inverters and Voltage Source PWM – Sections 8.4.1
<b>Apr. 9 – Lecture #29</b> Switch-Mode Inverters: Three-Phase Inverters with Square-Wave Operation; Switch Utilization; Voltage Output Ripple – Sections 8.4.2-8.4.4	<b>Apr. 9 – Lab #11</b> <b>Design Project Time</b>	<b>Apr. 11 – Lecture #30</b> Switch-Mode Inverters: Three-Phase Inverters with DC side Current; Switch Conduction – Sections 8.4.5-8.4.6	<b>Apr. 13 – Lecture #31</b> Switch-Mode Inverters: Effect of Blanking Time on Voltage in PWM Inverters – Section 8.5
<b>Apr. 16 – Lecture #32</b> Switch-Mode Inverters: Other Switching Schemes; Rectifier Mode of Operation – Sections 8.6-8.7	<b>Apr. 16 – Lab #12</b> <b>Design Project Time</b>	<b>Apr. 18 – Review for</b> <b>EXAM #2</b> Ch. 5-6, & 8 <b>OPEN BOOK</b> 2 Formulas Sheets	<b>Apr. 20 – EXAM #2</b> Ch. 5-6, & 8 <b>OPEN BOOK</b> 2 Formulas Sheets
<b>Apr. 23 – Lecture #33</b> Selected Topics in Power Electronic Applications: Power Supplies (Switching dc, Power Conditioning, UPS) – Ch. 11	<b>Apr. 23 – Lab #13</b> <b>Design Project Time</b>  <b>- Draft Project Reports</b> <b>Due</b>	<b>Apr. 25 – Lecture #34</b> Selected Topics in Power Electronic Applications: Motor Drives (dc, ac Induction & Synchronous) – Ch. 12-15	<b>Apr. 27 – NO CLASS</b> <b>Nanook SpringFest</b>
<b>Apr. 30 – Lecture #35</b> Selected Topics in Power Electronic Applications: Residential/Industrial – Ch. 16	<b>Apr. 30 – Project</b> <b>Evaluations</b> <b>(Demonstrations)</b>	<b>May 2 – Lecture #36</b> Selected Topics in Power Electronic Applications: Utility (HVDC, SVC, and Grid Connected Renewables) – Ch. 17	<b>May 4 – Lecture #37</b> Selected Topics in Power Electronic Applications: Optimizing the Utility Interface (Smart Grid) – Ch. 18
		<b>May 11 – FINAL EXAM</b> <b>10:15 AM – 12:15 PM</b>  <b>FINAL PROJECT</b> <b>PRESENTATIONS</b>  <b>- Final Project Reports</b> <b>Due</b>	

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**Electrical and Computer Engineering Department**  
**EE 408/608 – Power Electronics Design**  
**Spring 2012**

**Senior/Graduate Design Project: Regulated DC Hard Drive Bay Power Supply Design**

**Objective:**

The objective of this project is to design, simulate using PSPICE, and build a regulated dc power supply fed from a single phase AC source that meets the design requirements listed below. You will need to combine what you learn in the class lecture and laboratory and additional literature such as technical articles and/or materials from the textbook to complete this project.

**Design Problem Statement:**

You work for WIES Power Electronics Design and your boss has asked you to design a regulated dc source to power a hard drive bay in a server to store power systems data that is being uploaded from remote monitoring sites in 20 remote communities in Alaska. Each community has a single 1TB hard drive in the bay. Each 1TB drive requires a constant 12 Vdc to operate the motor and a constant 5Vdc to operate the drive electronics with a typical average power consumption model  $P_{typ} = (\text{Idle} * 90\% + \text{Write} * 2.5\% + \text{Read} * 7.5\%) / 100\%$  and a maximum average power consumption model  $P_{max} = (\text{Write} + \text{Seek} + \text{Read} * 3) / 5$  with idle, write, read, and seek powers to be provided. The available supply is single phase 120 Vac +/- 5% at 60 Hz with an unknown supply inductance  $L_S$ . The use of a isolation transformer is required in the design and the leakage reactance must be less than 10% based on its ratings.

**Design Requirements (Graduate Credit in BOLD):**

- 1) The dc voltages applied to the hard drive motor and drive electronics must remain constant at 12 Vdc and 5 Vdc, respectively.
- 2) The proper amount of additional supply inductance must be employed to meet the German VDE standards (inductive reactance is a minimum of 5% of the base impedance).
- 3) An isolation transformer is required in the design and the leakage reactance must be less than 10% based on its ratings.
- 4) The  $\text{THD}_i$  of the supply current for this system must be less than 20%.
- 5) The  $\text{THD}_v$  of the voltage at the point of common coupling (PCC) must be less than 10%.
- 6) The percent voltage ripple at the output of the dc-dc converter must be less than 5%.
- 7) Simulate the design in PSPICE before construction of the dc regulated power supply.
- 8) **The power supply must operate from a single phase 120 Vac +/- 5% at 60 Hz or single phase 250 Vac +/- 5% at 50Hz supply with unknown supply inductance  $L_S$ .**
- 9) **The power supply must provide power to operate two 9 Vdc & 2 Adc cooling fans.**

**Performance Verifications Plots/Calculations Requirements:**

- 1) Simulate the design in PSPICE. Is the design possible with the given requirements? If not, which requirement(s) cannot be achieved? Why not?
  - a. Plot the waveforms  $v_s$ ,  $i_s$ ,  $v_d$ ,  $i_d$ , and  $v_{PCC}$  of the diode rectifier on one plot using PSPICE. Use the supply side (primary) of the transformer as the point of common coupling (PCC).
  - b. Use Fourier analysis in PSPICE to compute  $I_{sT}$ ,  $I_s$ , DPF, PF, and  $\text{THD}_i$ .
  - c. Also compute the  $\text{THD}_v$  of the voltage at the point of common coupling (PCC).
  - d. Plot the waveforms  $v_d$ ,  $i_d$ ,  $v_o$ , and  $i_o$  of the dc-dc converter using PSPICE.
  - e. Calculate the peak-to-peak and percent voltage ripple in  $v_d$  and  $v_o$ .
- 2) Verify all design requirements on completed power supply.

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**Senior/Graduate Design Project: Regulated DC Hard Drive Bay Power Supply Design**

**Team Approach:**

*You will be working in teams of two* on this design project and each of the team members will have specific tasks that will be documented in a project workplan as part of the proposal. The instructor will sign off on each task in the workplan as it is completed.

**Reports:**

*You are required* to write four reports as part of the design project

- 1) **Proposal (Due: Monday, Feb. 7, 2010):** *You are required* to write a project proposal (5 pages or less) which lays out your intended design based on the given requirements. Include preliminary PSPICE schematics and necessary output text files. *You will be required* to submit a project workplan outlining the tasks for each team member as part of the proposal. You will meet with the instructor to discuss the proposal.
- 2) **Midterm Progress (Due: Monday, March 2, 2010):** *You are required* to write a midterm progress report (5 pages or less) which discusses your progress up to the time of the mid-term progress presentations. You will meet with the instructor to discuss the mid-term progress.
- 3) **Draft Report (Due: Monday, April 25, 2010):** *You are required* to write a draft project report (approximately 20 pages) explaining your design based on the given requirements. Include PSPICE and CADENCE schematics and necessary output text files in an Appendix. Also make sure to include any references and annotate them in order of reference within the report. You will meet with the instructor to discuss edits to the draft report.
- 4) **Final Report (Due: Wednesday, May 11, 2010):** *You are required* to complete a final project report (approximately 20 pages) explaining your design based on the given requirements and making final conclusions and edits from the draft report. Include PSPICE and CADENCE schematics and necessary output text files in an Appendix. Also make sure to include any references and annotate them in order of reference within the report.

**Report Format:**

The proposal and reports should be sufficient in length to cover the theory, design, and simulation. The reports should give background on the specific application and explain how it applies to power electronics. Your report should also include any pertinent tables, figures, PSPICE inputs and outputs and CADENCE schematics for the purpose of demonstrating the application. This should be written like a standard research report with references. Please provide a list of numbered references (including websites) in the order referenced in the report and use the numbers in square brackets to annotate the referenced material in the report. Figures and tables need to have captions. Captions for figures are below the figure, while captions for tables are above the table. Also, please number the pages beginning with the second page. If you have an excessive amount of design and simulation results, you should include it in an Appendix with page numbers and refer to it in the main document.

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**Presentations:**

*You are required* to give three team presentations on this design project:

- 1) **Proposal (Lab Time: Monday, Feb. 7, 2010):** *You are required* to give a 15 minute project proposal presentation which lays out your intended design based on the given requirements and a workplan with tasks outlined for both team members. Include preliminary PSPICE schematics.
- 2) **Midterm Progress (Lab Time: Monday, March 2, 2010):** *You are required* to give a 15 minute midterm progress report presentation which presents your progress up to the time of the presentation. Include PSPICE and CADENCE schematics and any documented design results.
- 3) **Final Report (Final Exam Time: Wednesday, May 11, 2010):** *You are required* to give a 20-minute final project presentation explaining your design based on the given requirements and making final conclusions. Include PSPICE and CADENCE schematics and data/plots that support the final design requirements. The final presentations will occur during the scheduled Final Exam time which is Wednesday, May 11, 2011 from 10:15AM-12:15PM.

**Grading:**

<b>Project Reports</b>	
<b>Proposal</b>	<b>50</b>
<b>Mid Term Progress</b>	<b>50</b>
<b>Draft Report</b>	<b>150</b>
<b>Final Report</b>	<b>100</b>
<b>Oral Presentations</b>	
<b>Proposal</b>	<b>30</b>
<b>Mid Term Progress</b>	<b>30</b>
<b>Final</b>	<b>90</b>
<b>Project Performance</b>	<b>150</b>
<b>Total Project</b>	<b>650</b>