Subject Description Form

Subject Code	EIE4402
Subject Title	Power Electronics
Credit Value	3
Level	4
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	**To enable students to gain knowledge and understanding in the following aspects:** 1. Fundamentals of power electronics. 2. The concepts and operating principles of power electronics circuits. 3. Design procedures and techniques of power electronics systems. Sustainable development is one of the emerging societal objectives in China and the world at large. The knowledge & experience gained from this subject provide some of the technical fundamentals to address this kind of development.
Intended Subject Learning Outcomes	**Upon completion of the subject, students will be able to:** <u>Category A: Professional/academic knowledge and skills</u> 1. Understand the fundamental principles and applications of power electronics circuits. 2. Solve problems and design switching regulators according to specifications. 3. Use Computer-aided techniques for the design of power converter circuits. 4. Appreciate the latest developments in power electronics. <u>Category B: Attributes for all-roundedness</u> 5. Communicate effectively. 6. Think critically and creatively. 7. Assimilate new technological and development in related field.
Subject Synopsis/ Indicative Syllabus	**Syllabus:** 1. <u>Introduction to Power Electronics</u> Overview of power electronics systems: applications and areas of future development. 2. <u>Basic Switching Regulator Topologies</u> Basic operations. Critical inductance criterion. Continuous- and discontinuous-conduction modes. Practical considerations. Merits and drawbacks. 3. <u>Mathematical Modelling of Switching Regulators</u> Small-signal approximation for linearity. Applications of approximation techniques. Switching regulator transfer functions and salient features. 4. <u>Switching Regulators with Transformer Isolation</u> Flyback converter. Forward converter. Half- and full-bridge converters. Push-pull converter. Areas of application. 5. <u>Feedback Control Design</u> Classical control design. Bode plot and Nyquist stability criterion. Voltage- and current-mode controls.

6. Magnetic Components
   Inductor. Transformer. Saturation, hysteresis, and residual flux.

7. Latest Development in Power Electronics

Laboratory Experiments:

1. Computer-aided design of switching regulator.
2. Design of a closed-loop controlled power converter circuit.

Teaching/ Learning Methodology

Teaching and Learning Method	**Intended Subject Learning Outcome**	**Remarks**
Lectures, supplemented with interactive questions and answers, and short quizzes	1, 2, 6, 7	In lectures, students are introduced to the *knowledge* of the subject, and *comprehension* is strengthened with interactive Q&A and short quizzes. They will be able to *explain* and *generalize* knowledge in the design of power converter circuits.
Tutorials where design problems are discussed, and are given to students for them to solve	1, 2, 5, 6	In tutorials, students *apply* what they have learnt in analyzing the cases and solving the problems given by the tutor. They will *analyze* the given information, *compare* and *contrast* different scenarios and propose solutions or alternatives.
Laboratory sessions, where students will perform a mini-project by computer simulations and experimental verifications. They will have to write a report on their mini-projects.	2, 3, 4, 5, 6	Students *acquire* hands-on experience in using CAD tools in power converter design, and *apply* what they have learnt in lectures/tutorials to do a mini-project on the design of a power converter circuit.
Assignment and Homework	1, 2, 3, 4, 5, 6	Through working assignment and homework, students will develop a firm understanding and *comprehension* of the *knowledge* taught. They will *analyze* given information and *apply* knowledge in solving problem. For some design type of questions, they will have to *synthesize* solutions by *evaluating* different alternatives.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific Assessment Methods/Tasks	% Weighting	Intended Subject Learning Outcomes to be Assessed (Please tick as appropriate)						
		1	2	3	4	5	6	7
1. Continuous Assessment (total 50%)								
• 1 Assignment	8%	✓	✓			✓	✓	
• Laboratory works and reports	30%		✓	✓	✓	✓		
• Mid-semester test	6%	✓	✓	✓	✓		✓	
• End-of-semester test	6%	✓	✓	✓	✓		✓	
2. Examination	50%	✓	✓	✓	✓		✓	
Total	100 %							

The continuous assessment consists of assignments, quizzes, and two tests.

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Specific Assessment Methods/Tasks	Remark
Assignment/Homework/ Case study reports	Assignment/Homework and case study reports are given to students to assess their competence level of *knowledge* and *comprehension*, ability to *analyze* given information, ability to *apply* knowledge and skills in new situation, ability to *synthesize* structure, and ability to evaluate given data to make judgment. The criteria (i.e. *what* to be demonstrated) and level (i.e. the *extent*) of achievement will be graded according to six levels: (A+ and A), Good (B+ and B), Satisfactory (C+ and C), Marginal (D) and Failure (F). These will be made known to the students before an assignment/homework is given. Feedback about their performance will be given promptly to students to help them improvement their learning.
Laboratory works and reports	Students will be required to perform a mini-project and submit a report. The emphasis is on assessing their ability to *use* VLSI CAD tools effectively to perform VLSI *design*. Expectation and grading criteria will be given as in the case of assignment/homework.
Mid-semester test	There will be a mid-semester test to evaluate students' achievement of all the learning outcomes and give feedback to them for prompt improvement. Expectation and grading criteria will be given as in the case of assignment/homework.

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<tr><td></td><td colspan="2"><table>
<tr><th>Specific Assessment Methods/Tasks</th><th>Remark</th></tr>
<tr><td>End-of-semester test and Examination</td><td>There will be an end-of-semester test and examination to assess students' achievement of all the learning outcomes. These are mainly summative in nature. Expectation and grading criteria will be given as in the case of assignment/homework.</td></tr>
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<tr><td rowspan="6">Student Study Effort Expected</td><td>Class contact (time-tabled):</td><td></td></tr>
<tr><td>• Lecture</td><td>24 Hours</td></tr>
<tr><td>• Tutorial/Laboratory/Practice Classes</td><td>15 hours</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>• Lecture: preview/review of notes; homework/assignment; preparation for test/quizzes/examination</td><td>36 Hours</td></tr>
<tr><td>• Tutorial/Laboratory/Practice Classes: preview of materials, revision and/or reports writing</td><td>30 Hours</td></tr>
<tr><td>Total student study effort:</td><td>105 Hours</td></tr>
<tr><td>Reading List and References</td><td colspan="2">Reference Books:

1. R.W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, 2nd ed., Kluwer Academic Publishers, 2001.
2. M.K. Kazimierczuk, Pulse-width Modulated DC-DC Power Converters, Wiley, 2008.
3. A.I. Pressman, K. Billings, T. Morey, Switching Power Supply Design, 3rd ed., McGraw-Hill, 2009.
4. C. Basso, Switch-Mode Power Supplies Spice Simulations and Practical Designs, McGraw-Hill, 2008.
5. N.S. Nise, Control System Engineering, 6th ed., Wiley, 2010.
6. R.C. Dorf, R.H. Bishop, Modern Control Systems, 12th ed., 2010</td></tr>
<tr><td>Last Updated</td><td colspan="2">March 2014</td></tr>
<tr><td>Prepared by</td><td colspan="2">Dr K.H. Loo</td></tr>
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