Western Michigan University, Electrical and Computer Engineering Department
ECE 4200 – ECE 5200 - 100 Power Electronics I (3 - 0), Fall 2018 Course Information and Policies

41196/100 – ECE 4200  9:30 - 10:20 am MWF (Lecture: Asumadu)
42484/100 – ECE 5200  9:30 - 10:20 am MWF (Lecture: Asumadu)

ACADEMIC INTEGRITY POLICY, DIVERSITY, RELIGIOUS OBSERVANCES, DISABILITY

“Students are responsible for making themselves aware of and understanding the University policies and procedures that pertain to Academic Honesty. These policies include cheating, fabrication, falsification and forgery, multiple submission, plagiarism, complicity and computer misuse. The academic policies addressing Student Rights and Responsibilities can be found in the Undergraduate Catalog at http://catalog.wmich.edu/content.php?catoid=24&navoid=974. If there is reason to believe you have been involved in academic dishonesty, you will be referred to the Office of Student Conduct. You will be given the opportunity to review the charge(s) and if you believe you are not responsible, you will have the opportunity for a hearing. You should consult with your instructor if you are uncertain about an issue of academic honesty prior to the submission of an assignment or test.

Students and instructors are responsible for making themselves aware of and abiding by the “Western Michigan University Sexual and Gender-Based Harassment and Violence, Intimate Partner Violence, and Stalking Policy and Procedures” related to prohibited sexual misconduct under Title IX, the Clery Act and the Violence Against Women Act (VAWA) and Campus Safe. Under this policy, responsible employees (including instructors) are required to report claims of sexual misconduct to the Title IX Coordinator or designee (located in the Office of Institutional Equity). Responsible employees are not confidential resources. For a complete list of resources and more information about the policy see www.wmich.edu/sexualmisconduct.

In addition, students are encouraged to access the Code of Conduct, as well as resources and general academic policies on such issues as diversity, religious observance, and student disabilities:

- Office of Student Conduct www.wmich.edu/conduct
- Division of Student Affairs www.wmich.edu/students/diversity
- University Relations Office http://www.wmich.edu/policies/religious-observances-policy
- Disability Services for Students www.wmich.edu/disabilityservices.”

OFFICIAL CONTACT PLACES/HOURS:

<table>
<thead>
<tr>
<th>Name:</th>
<th>Email:</th>
<th>Office:</th>
<th>Office Hours:</th>
<th>Tel:</th>
<th>Fax:</th>
<th>Classroom Assigned:</th>
<th>Class Hours:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnson Asumadu</td>
<td><a href="mailto:johnson.asumadu@wmich.edu">johnson.asumadu@wmich.edu</a></td>
<td>CEAS B-0224</td>
<td>10:30 -11:30 a.m.</td>
<td>+1 (269) 276 – 3147</td>
<td>+1 (269) 276 – 3151</td>
<td>CEAS D-0115</td>
<td>9:30 - 10:20 AM</td>
</tr>
<tr>
<td>Lab: No Lab</td>
<td>Lab Hours: No Lab</td>
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Web Site Address: URL for course: http://homepages.wmich.edu/~jasumadu/index.html

PREREQUISITES:

ECE 2500, ECE 3200, ECE 3300 (or Equivalent Courses)

KEY DATES:

1st Hour Mid Term Test - October 12, 2018 Normal Class Hour
2nd Hour Mid Term Test - November 16, 2018 Normal Class Hour
Final Examination - According to the University’s Exam Schedule

COURSE MATERIALS:

Text Books:

2. ECE 4200 Power Electronics Lecture Notes Revised Edition by Asumadu. (Required)

Materials (Required):

1. SPICE Software (Free – it comes with required SPICE textbook).
2. Calculator: In this course I recommend that you use a scientific calculator that has at least the following features:
   (a) Performs operations for real numbers and complex numbers without requiring the user to perform the operations on the real part and the imaginary part, or magnitude and angle, separately,
   (b) solves linear algebra equations, including the case where the coefficients are complex,
(c) performs repetitive computations  
(d) finds roots of polynomials, linear and nonlinear equations, and  
(e) finds the inverse of at most 3x3 square matrix.

CATALOG DESCRIPTION:  
Analysis and design of power electronic systems, power sources, motor controls, tuning and sequencing circuits.

COURSE OBJECTIVES:  
1. Provide seniors in electrical engineering the ability to analyze and design power semiconductor switching and control strategies for the control, conversion, and protection of electric power.  
2. Integrate signal processing strategies into design concepts.

PRE-ASSESSMENT: (Required skills at the start of the course)  
1. Sending and receiving EMAIL, including attachments.  
2. Accessing information on a network using Web browsers and file utilities.  
5. Electronics - ECE 3200: Semiconductor diodes, BJTs, FETs, PSPICE Models and Electronic Circuits.  
6. ECE 3300: Electromagnetic devices, rotating machines and three-phase distribution systems.  
7. Semiconductor diodes, BJTs, FETs including PSPICE models and electronic circuits.  
9. Applying correct electrical engineering units (and symbols) to quantities using the English and SI systems: Ohms (Ω), Farads (F), Henries (H), Amperes (A), Volts (V), Volt-Amperes (VA), and Watts (W)  
10. Applying correct engineering factors: kilo (k = 10^3), mega (M = 10^6), giga (G = 10^9), tera (T = 10^12), milli (m = 10^-3), Micro (μ = 10^-6), nano (n = 10^-9), pico (p = 10^-12), and femto (f = 10^-15).

COURSE LONG-TERM BEHAVIOR:  
Behavior after 1 year:  
1. Ability to create system models from individual components with known performance characteristics that can be used to predict system response to standard input.  
2. Selecting appropriate tools and tests procedures to measure system response.  
3. Compile design report that documents simulation results, component selection, prototype construction, laboratory investigation/testing, and conclusion.  
4. Using manuals to select off-the-shelf components that are appropriate for use in a larger system.

LEARNING OUTCOMES (The relevant ECE Department learning outcomes a-k, are included in parenthesis):  
1. Use electronics and solid-state power devices for the control, conversion, and protection of electrical energy. (a, b, c, d, e, i, k)  
2. Ability to design switching using power semiconductor devices. (a, b, c, e, i, k)  
3. Apply control techniques to meet desired switching objectives. (b, c, e, i, k)  
4. Integrate signal processing strategies into the control concepts. (a, b, c, d, e, i, k)  
5. Ability to specify design criteria (power, efficiency, ripple voltage and current, harmonic distortions, power factor). (a, b, c, d, e, g, i, k)  
6. Ability to select components, interpret terminal characteristics of the components, model components, design circuit, and understanding operation of power electronics circuits. (c, d, e, i, k)  
7. Use application software (PSPICE, MATLAB, MATHCAD) for simulating circuits with power semiconductor devices, motor drives, and different loading conditions. (a, b, c, e, i, k)
COURSE ORGANIZATION:
In power electronics, power semiconductor devices (diodes, transistors, etc.) are used as switches and these switches can be controlled by microelectronics for the conversion and protection of electrical energy. Therefore, the same power electronics circuit can have different forms (topologies) within a cycle depending on the time(s) the switches are turned on/off. Here are some of the things you will encounter in this course:
1. You will be expected to draw nodal voltage and branch current waveforms for varying topologies of power electronics circuits.
2. You will be expected to use PSpice to help you verify the waveforms of 1).
3. You will be expected to design converter circuits to control loads such as electric drives and R-L.

Students learn best if they understand how to learn, if they aware of all aspects of the process of learning, and if they take personal responsibility for their own learning; some of the principles of Process Education. The content of this course is classified into five categories and collectively called Knowledge Map.

Concept: Idea that represents a set of relationships.
Processes: Series of actions, steps, or changes that bring about a result.
Tools: Something that assists in carrying out a process.
Context: A well-defined situation in which concepts, processes, and tools may be applied.
Culture: "Way of being."

For example, consider the idea of a power semiconductor switch. A Power Semiconductor Switch is a concept that involves causing, say a transistor, to turn ON/OFF to convert electrical energy (example AC to DC) in order to control and protect a load. Solving the different circuit topologies for nodal voltages and branch currents, and troubleshooting are all processes of using a switch. Transistor, (P)SPICE simulation, etc. can be thought of as tools that are used to assist the Switch Building Process. Data sheets, safety precautions, etc. can be thought of as contexts (they allow us to apply concepts, processes, and tools)

COURSE KNOWLEDGE MAP:
Key Concepts
Power Semiconductor Devices
Switches
Indicators
Ohms Law
Kirchoff’s Current Law
Kirchoff’s Voltage Law
Fourier Transformer
Equivalent Circuits
   Equivalent Resistor
   Current Source
   Voltage Source
Waveform Behavior
   DC, Sine wave, Square Wave
   Triangular Wave, PWM Wave
Processes
Circuit Diagrams
   Nodes, Branches
   Active Voltage Source
   Active Current Source
   Resistors, Capacitors
   Inductors

Contexts
Data Sheets
Safety Precautions
Norton’s Equivalent Circuit
Thevenin’s Equivalent Circuits

Tools
Diodes
   SBD, MPS
   Bipolar Transistors
   BJT, IGBT, SIT
Metal oxide and Junction Field Effect Transistors
   MOSFETs, JFETs, COOLMOS
Thyristors
   SCR, RCT, TRIAC, GTO, MTO, ETO, IGCT, SITH, MCT
New Power – Element Technology
   CSTBT, RC-IGBT, RB-IGBT, PT-IGBT, NPT-IGBT, LPT-CSTBT
New Materials
   SiC, GaN, AlGaN
Simulation
   PSPICE
Simulation Report
Converters
DC-DC, AC-DC, AC-AC,
DC-AC

Problem-Solving
Troubleshooting

COURSE EVALUATION:
Individual Record Keeping (Maximum Points: 10%)
  Homework Assignments (Maximum Points: 10%)
  Reading Assignments
Examinations (Maximum Points: 70%)
  2 Mid Term Tests (20% of each)
  Final Examination (30%)
PSPice and Reports (Maximum Points: 20%)

Grading Scale
<table>
<thead>
<tr>
<th>Maximum Points (%)</th>
<th>GRADE</th>
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<tbody>
<tr>
<td>100 - 85</td>
<td>A</td>
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<tr>
<td>84 - 80</td>
<td>BA</td>
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<td>69 - 65</td>
<td>C</td>
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<tr>
<td>64 - 60</td>
<td>D</td>
</tr>
<tr>
<td>59 &amp; BELOW</td>
<td>E</td>
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Policy on Homework and SPICE:
Homework and SPICE assignments are assigned during class periods and are due at the scheduled time. Problems must be done neatly, submitted in numerical order on 8 1/2 X 11 inch paper, one side only. HOMEWORK AND SPICE TURNED IN LATE WILL RECEIVE NO CREDIT. If you have questions about any homework, project, or do not understand any course materials, you must see me in B-0224 PARKVIEW CAMPUS as soon as possible. Solutions to all homework problems and projects will be made available.

Please do not skip doing homework and PSPICE assignments. Do not rely on reading through the solutions as techniques for studying for the course. The practice of consulting the solution before working a problem is a bad habit to acquire. It is much better to spend the effort trying to do the solution on your own - even if you are not able to complete the solution. You will find that the homework, though not impossible, is usually harder than the exam questions. Solving other problems on your own is the best way to understand the course materials and to study for the exams. There is a strong correlation between homework scores and course grades. Furthermore, homework scores are important in deciding borderline cases when determining course grades.

Policy on Class Attendance:
I highly recommend that you attend classes. Please, make every effort to attend every class. Low attendance is almost always correlated with low grades. “You must be present to win”.

General Policy on use of Electronic Equipment During Tests/Examinations
1. Electronic calculators/anything CANNOT be shared.
2. All cell phones/WIFI equipment must be turned off and NOT be on sight (preferably in your backpack).
3. I will inspect and make sure that your IPad/surface/etc. can only be used for ebook or eText, notes, etc. and if necessary these must be loaded before coming for test and/or exam. All WIFI connections must be turned off.
4. There should be no attempt to produce a video/scan/or any electronic copy of the examination questions from the paper containing the questions during the test/exam period.
5. There should be no attempt to produce a video/scan/or any electronic copy of your own solutions from the green/blue book or the loose sheets during the test/exam period.
6. If you see a student cheating, it is your responsibility to quietly call my attention to that. We must all stamp out cheating.
COURSE TENTATIVE SCHEDULE

August
29 – September 12
Switching Semiconductor Devices
Diodes, Transistors, Thyristors
Power Considerations
Ch. 1

September
14 – October 15
Diodes – Characteristics
AC-DC Rectifiers - Diodes Circuits
Single-phase and Three-phase
Harmonics
Ch. 2
Ch. 3

October 12
1ST HOURLY TEST: TEST I

October
22 – November 1
DC-AC Inverters
Single-phase and Three-phase
PWM Inverters
Ch. 6

November
3 – November 17
Thyristors – Characteristics
AC-DC Controlled Rectifiers
Single-phase and Three-phase
Ch. 7
Ch. 10

November 16
2ND HOURLY TEST: TEST II

19 – 30
Natural and Forced Commutations
AC-AC Converters
Cycloconverters - Single-phase, Three-phase
Ch. 11

December
3 – 7
Power Electronics Applications
Ch. 15

FINAL EXAM USING THE UNIVERSITY SCHEDULE

NOTE:
(i) AT THIS TIME I DO NOT INTEND TO GIVE MAKEUP HOMEWORK/TESTS/EXAM.

(ii) ALL THE INFORMATION PROVIDED ABOVE IS TENTATIVE AND SUBJECT TO CHANGE WITHOUT NOTICE

(iii) IF YOU ARE TAKING THIS COURSE AS ECE 5200, ADDITIONAL PROJECTS WILL BE ASSIGNED FOR THE COURSE.

OVERALL SCORE = 0.8*(TOTAL SCORE) + 0.2*(PROJECT SCORE)
## ECE 4200/5200 POWER ELECTRONICS: FALL 2018 TIME TABLE

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<th>#</th>
<th>ACTIVITY</th>
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<tbody>
<tr>
<td>1</td>
<td>Homework 1</td>
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<td>2</td>
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<td>6</td>
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<td>7</td>
<td>Homework 4</td>
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<td>8</td>
<td>Additional Project for ECE 5200 Starts</td>
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<td>9</td>
<td>Project 3</td>
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<td>16</td>
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<tr>
<td>17</td>
<td>Additional Project for ECE 5200 Due</td>
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YES, BUT...

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