Professor: Alexis Kwasinski, ENS348A, 232-3442, akwasins@utexas.edu

Office Hours: Dr. Kwasinski's office hours for this course are Tuesday from 2:00 pm to 4:00 pm and Thursdays from 2:00 pm to 3:30 pm. He is often in the power lab during the scheduled lab sessions.

Course Web Page: Materials will be posted on the course website (http://users.ece.utexas.edu/~kwasinski/EE462LS14.html)

Reference Textbooks (recommended, but not required): N. Mohan, T. M. Undeland, W. P. Robbins, *Power Electronics: Converters, Applications, and Design*, Third Edition, John Wiley & Sons, Inc., 2003. P. T. Krein, *Elements of Power Electronics.* New York and Oxford: Oxford University Press, 1998.

Description: Analysis, design, and operation of power electronic circuits. Emphasis on single-phase power conversion from AC to DC, DC to DC, DC to AC, and maximizing the power from photovoltaics (PV). Design and construction of 150W power electronic circuits in the power laboratory, and comparison of their performance to theory. A working circuit model will be available for observation, study, and improvement. Use of the ECE machine shop is not required, but those of you who want to use the shop are welcome to do so. But, to use the shop, you must first be "machine shop certified." See ECE technician Daryl Goodnight about shop certification and use.

Class, Lab Sessions, and Work Schedules:

- Lectures on TTH 12:30 pm – 2:00 pm, in ENS 127.
- Lab sessions in the power lab, ENS212:
  Sections 17060 and 17374: Thur. from 3:30 pm to 6:30 pm
  Sections 17065 and 17370: Wed. from 6:30 pm to 9:30 pm
- Use lab stations 15-22 during your scheduled lab time. These are the stations without PCs, so bring a hardcopy of the lab document. The hardcopy is useful for making notations as you proceed. You can also use the black cabinet tops, which are handy for construction and soldering.
- The group lab session times shown above may or may not be sufficient to complete your projects. Work with your assigned partner for that project to meet other times as needed during the regular 2nd floor ENS undergraduate teaching lab hours.
- If you have a highly constrained schedule (work hours, sports, Longhorn band, etc.) that will make it difficult to coordinate work times with a partner, or if there are good reasons that you should work by yourself, discuss with Dr. Kwasinski the possibility of being a *solo* student (i.e., no partner) for the semester. However, solo-teams will only be granted in extreme rare exceptions with well justified reasons
- Regarding conduct, it will be appreciated if students are 1. on-time, 2. refrain from eating, drinking, and disturbing others, and 3. conduct themselves in a manner consistent with a professional environment.
- Cell phones and laptops: In class, turn them off (unless you clear it with Dr. Kwasinski). In lab, laptops are OK.
- In some few weeks when additional time for completing the project is needed, lab work will replace either lecture times.
- Group arrangements and projects format or schedule may be modified due to unforeseen logistical issues. Any such changes will be posted online and announced in class.

TAs:

Graduate: Hunter Estes (support lab work and teach some lecture classes).
Undergraduate: To be announced.

Prerequisites: Credit with a grade of at least C- or registration for Aerospace Engineering 333T, Biomedical Engineering 333T, Chemical Engineering 333T, Civil Engineering 333T, Electrical Engineering 333T, Mechanical Engineering 333T, or Petroleum and Geosystems Engineering 333T.

Laboratory Projects: Read the lab document before starting to build! Projects are typically one-week long and require the building and testing of a circuit, and the writing of a report. Projects begin and end during the group lab sessions, according to unique section number. In addition to the group lab sessions, you should plan to work as needed during the regular 2nd floor ENS undergraduate teaching lab hours. Partners are going to be announced with the first assignment. Teams are going to remain unchanged during the semester. Partner requests for the entire semester will be considered if both partners sign and submit their request in writing by Monday 2/21. Partners must be in the same lab session. Solo/a requests will also be considered but granted only in exceptional circumstances. If a section has an odd-number of students, then a randomly selected graduate student will be asked to work solo/a.

When due, you will turn in your hardcopy report and circuit in team order. Print your names and team number on the top of your circuit. Circuits must be in good working condition. If there is any question about circuit condition, you will be asked to demonstrate your circuit. Messy circuits will have to be rebuilt.

On a regular basis, teams will present their tools to Prof. Kwasinski or the TAs for checking. Teams are responsible for missing or damaged tools.

Teamwork: You are expected to work with your assigned partner as a team, splitting the work equally. The parts belong to you both. Do not do the project by yourself, leaving your partner out of the loop, unless you have cleared it with Dr. Kwasinski and have a very good reason. Otherwise, you will receive no credit. Like in any job, you are expected to learn how to work well with your partner.

Reports: Each project culminates in a working circuit and a written report. Without a working circuit, there can be no report. Page 1 of the report should include a statement of the approximate division of work between the partners (in percent) for each of the following categories:

1. circuit construction, 2. circuit testing, and 3. report writing.

Reports (hardcopy only, no electronic) should be single-spaced and no longer than five pages, and stapled at the top left. Pages beyond the 5th will not be read or graded. Both team members receive the same project grade. Sample reports (pdf) are on the web page. Reports and circuits are due at the beginning of the group lab sessions according to unique section number and schedule. If the report is not ready when called, it will receive a late penalty. Thus, it is a good idea if each partner brings a hardcopy report in case the other partner is late. You are encouraged to prepare your reports in the IEEE Power Engineering Society or IEEE Power Electronics Society two-column technical paper format (see the web page).

Reports are scored with fractional letter grades (e.g., A+, A, A–, etc.). A is equivalent to 100 % and according to http://registrar.utexas.edu/students/grades, B is equivalent to 75% and so on. The grading criteria are 1. introduction, 2. description of results (including graphs and waveforms) and any problems encountered, 3. observations, 4. neatness, and 5. conclusions. Explain what you learned in the conclusions. Compare theory to actual results.

Students are expected to bring their own USB memory stick to save the oscilloscope snapshots. Lab project description documents, in both pdf and Word formats, are on the web page. You can copy-and-past figures from these documents if you wish, but all oscilloscope snapshots must be your own.

Tests and the Final Exam: These cover mostly the theory behind the circuits, and to a lesser extent the lab procedures. However, if you do your lab projects with a critical thinking approach and not just mechanically following a recipe, your labs will significantly help you to answer the exam questions right. You must always show sufficient work to justify your answers. When used, multiple choice questions usually have a provision for "other" answers. Grades for each test and the final exam are sometimes curved so that each has approximately the same average (around 80). There are no makeup tests, but if it works to your advantage, your lowest test (including a missed test) will be replaced with your final exam grade. Please do not ask to reschedule the final exam – the time and date are set university-wide.

If you have any questions about the grading of your test, follow this procedure: write down your concerns on a sheet of paper, staple it to your test, highlight on your test with a colored pen as needed to support your case, and return the stapled pack to Dr. Kwasinski within one week.

Laboratory Safety and Equipment: You are expected to take good care of the equipment in the power lab and of the tools with which you are provided. Be a good citizen in the lab, and clean up your messes. Power labs are unlike other labs that you have taken – the voltages are higher. In some cases you will be working with hazardous voltages over 100V. Furthermore, short circuit currents can easily exceed 50A, and significant arcing can occur. Thus, it is important for you to follow the safety procedures explained by Dr. Kwasinski and the TAs. Take off hand jewelry, watches, dangling neck-chains, etc. Always use safety glasses, specially when soldering or unsoldering! This is especially important when "unsoldering," because when an unsoldered piece pops loose, it can "splashback" hot solder into your eyes. In power labs, you never check out your wiring by simply energizing your circuit and "hoping for the best!" Triple-check your circuit wiring, with your partner, before energizing. Finally, remember to wash your hands after soldering because solder contains lead.

Power drills should only be used you need to drill a starter hole in hard wood. Use the drill boxes so you do not accidentally drill into a lab bench or table top.

Attendance: Students initial a sign-in sheet at the beginning of each class (but no later than 5 minutes after class starts). Attendance is also taken at every lab session. The attendance grade is scaled linearly according to the following two points: 100% attendance average gets full credit, and 50% attendance record gets no credit.

Please do not ask for excused absences, or late attendance sign-ins. At the end of the semester, students who have missed the sign-in sheets, have absences, or have other extenuating circumstances can prepare a written statement (signed hardcopy only) for Dr. Kwasinski, giving dates and circumstances. Staple your statement to your final examination. These will be taken into consideration when the course grades are determined.

A sample sign-in sheet is shown below.

In class, students initial the sheet as they arrive (but no later than 5 minutes after class starts). In lab, TAs check the names as the teams are called.

Initial Here	Student Name
	Student 1 Name
	Student 2 Name
	Student 3 Name
	Student 4 Name
	Student 5 Name
	Student 6 Name
	Student 7 Name
	Student 8 Name
	Student 9 Name
	Student 10 Name

Initial Here	Student Name
	Student 31 Name
	Student 32 Name
	Student 33 Name
	Student 34 Name
	Student 35 Name
	Student 36 Name
	Student 37 Name
	Student 38 Name
	Student 39 Name
	Student 40 Name

Grading Formula: Lab circuits and reports ----------50%
Two tests ---------- 10% each test
(note – one 8½ x 11" sheet of notes is permitted at each test)
Comprehensive final exam (according to the official U.T. schedule - Thursday, May 8, 2:00-5:00 pm) ----------20%
(note – one 8½ x 11" sheet of notes is permitted at the final exam)
Attendance (taken at all lab sessions, and at most lectures)----------10%

Fractional letter grade (A, A-, B+….) will be used for the final grade. . A is equivalent to 100 % and according to http://registrar.utexas.edu/students/grades, B is equivalent to 75% (3/4) and so on.

Group Lab Session Procedure: When a project is due, then each team will turn in their report (hardcopy only) and circuit when called, in team order. Be prepared to personally demonstrate your circuit to either Dr. Kwasinski or a TA for an "Accept" or "Reject" quality check inspection of performance and construction. If the report is not ready when called, but if it is turned in during the same lab period, the report will get a fractional letter grade penalty (e.g., A^- becomes B^+). After that, if it is turned in to Dr. Kwasinski during the following Monday's class, it will receive a full letter grade penalty. Later reports will not be accepted.

Prior to being called, each team should

- clean out their lockers and place extra plastic parts bags and other miscellaneous wires and hardware in one of the salvage tubs, and
- prepare their tools for inspection and properly organize them in their plastic bags. Then, as called forward (in team order),
  1. Turn in their report and circuit. Circuits must be in good working condition. Messy circuits will have to be rebuilt.
  2. Present their tools for inspection by Dr. Kwasinski and the TAs.
  3. Return their tools to the original locker.

After all old teams are processed, then teams will be called forward (in team order) to receive their new parts. Then, there will be lab demo if needed.

Lockers, Locks, and Parts: Our 48 lockers are the only square lockers on 2nd floor. They are on the north corridor. Lockers are assigned with the first project assignment.

All parts needed for building the circuits are provided. Most hardware, plus common parts such as screws and resistors, are kept in the power lab in the large wooden parts cabinet (southeast corner of the room) and in plastic electronic parts bin. Wire spools are mounted near the large wooden parts cabinet. Other parts are distributed at the beginning of projects.

Each team shares a tool kit (in two plastic ziplock bags, plus a static wrist band for use when handling MOSFETs. See list of tools and photos on following pages. Teams rotate lockers, but tool kits and wrist bands stay in the same lockers for the entire semester. Other tools, such as vises, are found in the power lab. Soldering irons and multimeters are obtained at the checkout counter. Students are given their own pair of safety glasses to keep with them for the entire semester.

Schedule:

Week	Lecture Periods	Lab Periods
Jan. 13	Course overview. Basic circuit components.	Orientation. Soldering demonstration and construction tips.
Jan. 20 (Monday is a holiday)	Basic circuit components (continue). SCRs, triacs, and light dimmers.	Assign Light Dimmer and Teams #I.
Jan. 27	Transformers, diode bridge rectifiers (DBR). Waveforms and definitions. *(Dr. K may be away on Tuesday and/or Thursday)*	Tool check. Assign DBR.
Feb. 3	Waveforms and definitions. (cont.) Photovoltaics and renewable energy. MOSFETs and MOSFET firing circuits. .	**Light dimmer circuit and report due**. Review DBR progress. Assign Solar. The solar lab does not require lockers. Show your hand plotted solar data on the lab document graph to the TAs **before March 7.**
Feb. 10	MOSFETs and MOSFET firing circuits (cont). DC-DC buck converters.	**DBR circuit and report due.** Tool check. Assign MOSFET firing circuit.
Feb. 17	Boost Converter	**MOSFET Firing Circuit and report due.** Assign Buck Converter.
Feb. 24	DC-DC SEPIC (converter). **Test #1 on Tuesday**	**Buck Converter circuit and report due.** Assign Boost Converter**.**
Mar. 3	PI controller for DC-DC converters.	**Boost Converter circuit and report due.** Assign SEPIC.
Mar. 10	Spring Break	Spring Break
Mar. 17	H-bridge inverter – basics and unipolar PWM controller.	**SEPIC Converter circuit and report due.** Assign PWM Controller.
Mar. 24	H-bridge inverters – isolated firing circuits.	Continue with ongoing projects.
Mar. 1	H-bridge inverters – bridge section and output filtering.	**PWM Controller circuit and report due.** Assign H-Bridge inverter circuit.
Apr. 7	H-bridge inverter – audio amplifier.	**Solar report due.** Assign Audio Amplifier and continue with ongoing project.
Apr. 14	H-bridge inverter – renewable power to grid.	Continuation of on-going project.
Apr. 21	Motor drives and Reliable power. **Test #2 on Tuesday**	**H-Bridge Inverter report due.** Start Power to Grid.
April 28	Additional applications and course evaluation	**Audio Amplifier report due.** Equipment check-in during the usual lab periods. **Power to Grid report due to the TAs or in Dr. Kwasinski's office door slot anytime before Friday, May 2.**

Notes – Unless told otherwise, reports are due at the beginning of your lab period (or, in some instances, during the following Monday's class). Hardcopy only. Partners are going to be announced with the first assignment. Teams are going to remain unchanged during the semester. Partner requests for the entire semester will be considered if both partners sign and submit their request in writing no later than Tuesday 1/21. Partners must be in the same lab session. All trips that Dr. K needs to take and he is aware of by the date of preparation of this syllabus are indicated in the above schedule. However, some additional trips unknown at this time may come up during the course of the semester. For example, due to the particular nature of his research Dr. K may need to travel to disaster areas on short notice. Although Dr. K will communicate these trips in advance along with any potential changes that these trips may cause, it is not possible to know at this time when those trips may occur.

The lab projects require a significant number of components and parts. Sometimes these parts need to be ordered during the semester and sometimes important parts may become unavailable without notice at the time of ordering them which may cause the postponement of a class project. If this situation happens, it will be communicated to the class along with the modified schedule.

TAs:

Graduate: Hunter Estes. Hunter will also teach a few of the lecture classes.
Undergraduate: To be announced

Both lab TA's will be present during regular lab hours.

The main duties of the lab TAs are to

1. Be helpful, have a positive attitude, and treat the students as our customers.
2. Assist students by being on duty **in the lab** during weekly lab sessions. (note – the first experiment requires more duty hours so that the students get off to a good start).
3. Grade the lab reports.
4. Practice with the model circuits well in advance to sharpen your proficiency in demonstrating and debugging circuits, and to make sure that you understand the circuits very well.
5. Be in charge of the weekly lab sessions, and be prepared to demonstrate the circuits and lab equipment there.
6. Help Dr. Kwasinski in supervising the inventory assistant (if available) in keeping track of the parts inventory and wood.
7. Help Dr. Kwasinski in supervising the inventory assistant in making sure that all lab equipment is functional and ready to go.
8. Help Dr. Kwasinski in supervising the inventory assistant and volunteers in taking apart the circuits and salvaging the reusable parts.
9. Assist Dr. Kwasinski in preparing the parts bags. These need to be ready-to-go one week in advance.
10. Verify early in the week that the parts bags and wood for the lab that begins on Thur/Fri are ready to go.
11. Send email updates to the course staff, alerting them of any particular problems or helpful tips.
12. Organize and oversee the end-of-semester tool, equipment, parts, and inventory wrap-up.
13. Do you job, do it well, and do it with a smile.

Lab TAs should report for duty 4-5 days before classes start, and remain a few days after the end of classes to complete the end-of-semester tool, equipment, parts, and inventory wrap-up.

Regarding the inventory, the main duties of the Lab TAs are:

1. **Each day,** one of them completes **List A**, replenishing the supplies as needed from the stock in the Checkout Room. When completed, List A should be signed and placed in the notebook in the TA's locking cabinet. Notify via email the entire EE462L staff upon completion, noting any shortages or issues.
2. **Each day,** same as above for **List B**.
3. **Each week**, same as above for **List C**.
4. **Each week**, same as above for **List D**.
5. When instructed, take apart the completed circuits and salvage the reusable parts. The IEEE-PES Student Chapter often provides additional volunteers.
6. Participate in the end-of-semester tool, equipment, parts, and inventory wrap-up.
7. Assist the TAs and Dr. Kwasinski as needed.

Place each completed list at the front of the corresponding notebook tab, and keep only the two most recent lists.

For Items 1 – 4, notify Dr. Kwasinski and the TAs via email of any shortages or problems.

List A: Daily Properly Stocked Requirements for the Power Lab
(based on 40 teams)

1. For the screw cabinet, approximately

- #8 x ½" self-tapping screws (1" deep in the drawer)
- #8 x ¾" self-tapping screws (1" deep in the drawer)
- #8 x 1" self-tapping screws (1" deep in the drawer)
- #6 x ¾" self-tapping screws (1" deep in the drawer)
- 20 of the #4-40 x 1" flat slotted nylon screws and hex nuts

- 200 of the #8-32, 1" machine screws, flat washers, split washers, and hex nuts
- 200 of the #6-32, ½" machine screws, flat washers, split washers, and hex nuts
- 200 of the #6-32, ¾" machine screws, flat washers, split washers, and hex nuts
- 200 of the #4-40 x ¾" machine screws, flat washers, split washers, and hex nuts

- 2000 of the #8, 16-14 spade terminals (about 1" deep in the drawer)
- 2000 of the #8, 22-16 spade terminals (about 1" deep in the drawer)

- 1,000 of the ¼", 22-26 quick disconnects
- 1,000 of the 3/16", 22-26 quick disconnects

- the equivalent of two full tubes of heat sink compound
- 100 of the 8" cable ties

2. For the student parts bin, approximately the number of items shown below. **Keep the 1/4W and 1/2W resistors, and the capacitors, in their plastic bags to minimize clutter and mixups**.

10Ω, 1/4W (200)
22Ω, 1/4W (200)
220Ω, 1/4W (200)
1kΩ, 1/4W (200)
1.2kΩ, 1/4W (200)
1.5kΩ, 1/4W (200)
1.8kΩ, 1/4W (200)
2.2kΩ, 1/4W (200)
3.3kΩ, 1/4W (200)
4.7kΩ, 1/4W (200)
9.53kΩ, 1/4W (200)
10kΩ, 1/4W (200)
15kΩ, 1/4W (200)
33kΩ, 1/4W (200)
47kΩ, 1/4W (200)
100kΩ, 1/4W (200)
220kΩ, 1/4W (200)
270kΩ, 1/4W (200)

1.5kΩ, 1/2W (100)
33kΩ, 1/2W (100)

0.01Ω, 3W (25)
2kΩ, 2W (50)
3.3kΩ, 1W (50)

6.8nF radial ceramic disk (100)
0.022μF radial ceramic disk (100)
0.01μF radial ceramic disk (100)
0.1μF radial ceramic disk, not dimmer (100)

5A slow-acting fuses (20)
10A fast-acting fuses (only when the H-bridge experiments are ongoing (20)

List A Continues on the Next Page

List A, Daily Properly Stocked Requirements for the Power Lab, continued
(based on 40 teams)

3. For the wire rack, the equivalent of one full spool of

- #14 black stranded
- #14 red stranded
- #14 tinned solid
- #16 black stranded
- #16 red stranded
- #16 white stranded (½ spool is OK)
- #16 blue stranded (½ spool is OK)
- #16 orange stranded (½ spool is OK)
- #22 red solid
- #22 green solid
- #22 blue solid
- #22 orange solid (½ spool is OK)
- #22 violet solid (½ spool is OK)

4. For the TA's locking cabinet

- a duplicate of the student parts bin
- two complete took kits
- two scope probes
- a multimeter
- 50 floppy diskettes and 4" x 6" 4-mil, pink plastic anti-static bags to hold them
- 10 extra 8" x 10", 6 mil plastic bags for tool kits
- a clamp-on ammeter
- 5 extra 15A fuses for the lab benches

Signed:_____

Date:_____

List B, Daily Equipment Check List

(number and condition of items in the Power Lab, along with comments as needed)

Equipment Item	Number	Comments
DC Wall Warts		(daily check – keep in 6" x 8", 6 mil, clear plastic bags)
AC Wall Warts		(daily check – keep in 6" x 8", 6 mil, clear plastic bags)
5Ω, 225W Resistor Load Banks		(daily check)
10Ω, 225W Resistor Load Banks		(daily check)
Variacs		(daily check)
Panavises		(daily check)
Drill Stations (including bits, extra batteries, chargers)		(daily check)
Lab equipment properly stored (including lost and found basket, and jumper basket)	NA	(daily check)
Lab benches		(daily check to make sure bench AC outlets have power)
TA locking cabinet in proper order	NA	(daily check)

Signed:_____

Date:_____

List C, Weekly Equipment Check List

(number and condition of items in the Power Lab, along with comments as needed)

Equipment Item	Number	Comments
3-Headlight Load Banks		(weekly continuity check)
Solar Tester Rheostats		(weekly check, no rough spots)
25V Transformer Boards		(weekly check 5A fuses)
Isolation Transformers		(weekly check)
120V, 150W Light Bulb Load Banks		(weekly continuity check)
Solar Panel Stations		(weekly check the switch, and also short circuit current)
Anti Static Mats		(weekly check the ground connections)
Installed ring static ground connecters at bench and pole outlets	NA	(weekly check for damage)
DC Wall Warts		(Weekly load check in testing circuit. Expect Vdc about 12V, Vac < a few mV)
AC Wall Warts		(Weekly load check in testing circuit. Expect both LEDs to have same brightness)

Signed:_____

Date:_____

List D, Weekly Inventory Check List for Items Stored in the Checkout Room

(number in parenthesis is the inventory to maintain, based on 40 teams)

Item	Approx. No.
#8-32, 1" machine screws (1,000)	
#8 flat washers (1,000)	
#8 split washers (1,000)	
#8-32 hex nuts (1,000)	

#6-32, ½" machine screws (1,000)	
#6-32, ¾" machine screws (1,000)	
#6-32 flat washers (1,000)	
#6-32 split washers (1,000)	
#6-32 hex nuts (1,000)	

#4-40 x ¾" machine screws (1,000)	
#4-40 flat washers (1,000)	
#4-40 split washers (1,000)	
#4-40 hex nuts (1,000)	

#8 x ½" self-tapping screws (5,000)	
#8 x ¾" self-tapping screws (5,000)	
#8 x 1" self-tapping screws (1,000)	

#6 x ¾" self-tapping screws (2,000)	

#4-40 x 1" flat slotted nylon screws (1,000)	
#4-40 nylon hex nuts (1,000)	

#8, 22-16 spade terminals (10,000)	
#8, 16-14 spade terminals (10,000)	

¼", 22-26 quick disconnects (2,000)	
3/16", 22-26 quick disconnects (2,000)	

Heat sink compound (5)	

5A slow-acting fuses (200)	
10A fast-acting fuses (200)	
15A fuses for lab benches (10)	

#14 black stranded (Two 500 foot spools)	
#14 red stranded (Two 500 foot spools)	
#14 tinned solid (Three 100 foot spools)	

#16 black stranded (Two 1,000 foot spools)	
#16 red stranded (Two 1,000 foot spools)	
#16 white stranded (Two 1,000 foot spools)	
#16 blue stranded (Two 1,000 foot spools)	
#16 orange stranded (Two 1,000 foot spools)	

#22 red solid (Two 1,000 foot spools)	
#22 green solid (Two 1,000 foot spools)	
#22 blue solid (Two 1,000 foot spools)	
#22 orange solid (Two 1,000 foot spools)	
#22 violet solid (Two 1,000 foot spools)	

9" x 12" 6-mil clear plastic bags (250) (bundled in 25's)	
8" x 10" 6-mil clear plastic bags (500) (bundled in 25's)	
6" x 8" 6-mil, clear plastic bags (1000) (bundled in 25's)	
6" x 6" 4-mil, clear plastic bags (500) (bundled in 40's)	
8" x 10" 4-mil, pink plastic anti-static bags (100) (bundled in 100's)	
4" x 6" 4-mil, pink plastic anti-static bags (500) (bundled in 50's)	

0.01Ω, 3W (200)	
10Ω, 1/4W (600)	
22Ω, 1/4W (600)	
220Ω, 1/4W (600)	
1kΩ, 1/4W (600)	
1.2kΩ, 1/4W (600)	
1.5kΩ, 1/4W (600)	
1.5kΩ, 1/2W (600)	
1.8kΩ, 1/4W (600)	
2kΩ, 2W (100)	
2.2kΩ, 1/4W (600)	
3.3kΩ, 1/4W (600)	
3.3kΩ, 1W (100)	
4.7kΩ, 1/4W (600)	
9.53kΩ, 1/4W (600)	
10kΩ, 1/4W (600)	
15kΩ, 1/4W (600)	
33kΩ, 1/4W (600)	
33kΩ, 1/2W (200)	
47kΩ, 1/4W (600)	
100kΩ, 1/4W (600)	
220kΩ, 1/4W (600)	
270kΩ, 1/4W (600)	

6.8nF radial ceramic disk (200)	
0.022µF radial ceramic disk (200)	
0.01µF radial ceramic disk (400)	
0.1µF axial, for dimmer (200)	
0.1µF radial ceramic disk, not dimmer (600)	

8" cable ties (400)	

1" x 6" wood, 7" long pieces (50)	
1" x 6" wood, 10" long pieces (150)	
1" x 6" wood, 12" long pieces (100)	
1" x 10" wood, 16" long pieces (50)	

Signed:_____

Date:_____

Tools:

Tool Kit #1, Pliers and Wire Strippers (7 items)

- Crimping and stripping tool, red 3M TH-440 (Mouser #517-TH-440, or Grainger #4X316), or Xcelite 104CG (Mouser #578-104CG). Two of these.
- Long nose pliers with cutter, 6" blue Channellock #326 (Lowe's Home Improvement, or Grainger #3LY70)
- Slipjoint pliers with cutter, 6" blue Channellock #526 (Lowe's Home Improvement, or Grainger #3LY75)
- Diagonal cutting pliers, 4 and ½" 1/2 green Utica U463, or 5" green Xcelite S475JS (Mouser #578-S475JS)
- Wire strippers with (or without) spring and cam adjustment, DES Tools (Mouser #5876-103S or #5876-100)

Tool Kit #2, Screwdrivers and IC Extractor (7 items). Two of these.

- 8&1/8", Phillips #2, yellow, Xcelite X102 (Mouser #578-X102)
- 3" slotted, 3/16" wide, black and yellow, Stanley 66-015 (Grainger #6C251)
- 3" slotted, 5/32" wide, yellow, Xcelite R5323 (Newark #34F259)
- 3" slotted, 1/8" wide, red, Xcelite R183 (Mouser #578-R183)
- Trimmer potentiometer adjustment tool, Vishay/Spectrol (Mouser #594-8T000)
- IC extractor tool, spring steel (Mouser #524-9227)

Tool Kit #1 (has **two** of the large crimping and stripping tools)

Please keep Tool Kits #1 and #2 grouped as shown in their reclosable bags

Tool Kit #2 (has **two** of the large Phillips screwdrivers)
To prevent damage to screwdriver tips, always use the largest screwdriver that fits the screw.

Additional Tools: Safety Glasses and Static Wristband (one per team)
Please keep the safety glasses and static wristband in their individual reclosable bags or boxes. The safety glasses' lenses are easily scratched if bagged with tools.
(Safety glasses (over glasses type), UVEX S0112, Grainger #6T359)
(Static wristband with 6' coil cord, SPI-Westek 95113, Mouser #809-SP106B-B6)

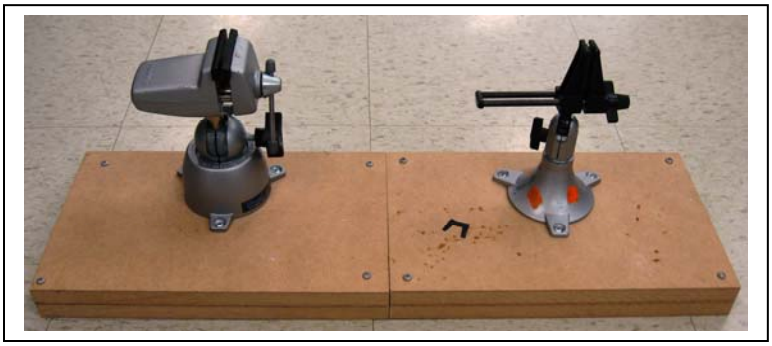
Additional Tool: Oscilloscope Probe (Agilent 10074C 10:1) in Anti-Static Bag
(Your tool kit has one probe. Additional probes are available at the check-out window.)

Other Stock Equipment and Tools: Stock equipment and tools that you will use regularly include

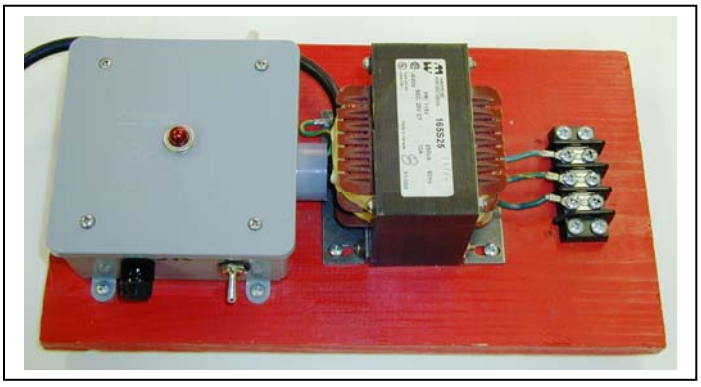
- 120V input, 0-140V output, 1.4kVA, 10A variable autotransformers (Superior Electric POWERSTAT L2M116C, Newark #91F5311)
- Oscilloscopes (Agilent 54621A, 60MHz)
- Vises (Panavise Standard 301, Mouser #591-301, or Jr. Mini 201, Mouser #591-201)
- 115V/115V, 500VA line isolation transformers (Hammond 171E, Newark #96F5547)
- Two portable hand drills and 3/32" bits for drilling starter holes in wood. Use the drill boxes so you do not accidentally drill into a lab bench of table.

Variac

Isolation Transformer



You will also use two other pieces of equipment that were assembled especially for this course. These are 120/25V, 250VA transformers mounted on boards (Hammond 165S25, Newark #92F1340), and three series automobile headlights as load banks. Both are shown below. The plastic electrical switch box to the left of the transformer contains a toggle switch, 5A "slow blow" fuse, fuse holder (Bussmann #HJM, Newark #27F819), and neon indicator light (LC&D #75R-2211T, Newark #16F736).



120/25V Transformer Board

Three Series Headlight Load Bank

Special Generous Donation: Schweitzer Engineering Labs donated more than thirty SEL-421s for our power engineering laboratory. In EE462L, they are used as voltmeters/ammeters/wattmeters and as waveform capture devices.

Schweitzer Engineering Labs SEL-421 Relay
(the SEL-421 also serves as three-phase meter and event-triggered waveform capture device)

We power the SEL-421s through in-line ground fault interrupters (Hubbell GFP2CA).

Plastic Bags: Reclosable plastic bags (Minigrip from Consolidated Plastics, www.consolidatedplastics.com) are essential. They are

- 9" x 12", 6 mil clear plastic for large items or circuit parts
- 8" x 10", 6 mil, clear plastic for tools or circuit parts
- 8" x 10", 4 mil, pink plastic anti-static for scope probes
- 6" x 8", 6 mil, clear plastic for circuit parts, wall warts, or safety glasses
- 6" x 6", 4 mil, clear plastic for circuit parts
- 4" x 6", 4 mil, pink plastic anti-static for sensitive components, anti-static wristbands, and floppy diskettes.

Suggestions for Improvements: Your suggestions for improving the course will be greatly appreciated. Many improvements have been made thanks to students from previous semesters. Consider the following:

- Do you have ideas for improving the experiments?
- Are there errors or clarifications needed in the lab documents?
- Should any of the experiments be deleted? If so, which ones?
- Should new experiments be added? If so, what topics?
- Do you see ways to increase your efficiency in completing the experiments (tools, equipment, supplies and parts, bench scheduling, storage, partner assignment, lockers, etc.)

List E: Other Inventory Items To Be Fully Stocked at Semester Start

(stored in Checkout Room (CR), or in ENS624B)

Item	Actual No.
Tool kits #1 (in CR)	
Tool kits #2 (in CR)	
Safety glasses (in CR)	
Static wristbands (in CR)	
Oscilloscope probes (in CR)	
Light dimmer kits (in CR)	
DBR kits (in CR)	
MOSFET Firing Circuit kits (in CR)	
Buck Converter kits (in CR)	
Buck/Boost Converter kits (in CR)	
Inverter Control Circuit kits (in CR)	
Inverter Isolated Firing Circuit kits (in CR)	
Inverter H-Bridge kits (in CR)	

Item	Actual No.
Steel corner brackets, 1” drilled special (in 624B)	
Steel corner brackets, 1½” (in 624B)	
Steel corner brackets, 2” (in 624B)	
Steel corner brackets, 2” drilled special (in 624B)	
DC jacks (in 624B)	
Green plugs (in 624B)	
Protoboards, EXP350, 3.6” (in 624B)	
Protoboards, EXP300, 6” (in 624B)	
Terminal blocks, 2-terminal, 30A (in 624B)	