

Course Syllabus

Vehicle Electrical systems

Course:

Vehicle Electrical Systems, IET 315, 4 credits

Course Description:

The main emphasis of the course is on the application of magnetic and electrical theory to real industrial and transportation applications. The course covers starting, charging, regulation, and ignition systems as used in automobiles, industrial materials handling vehicle, and recreational vehicles. There will be detailed disassembly, troubleshooting, diagnosis, and repair of alternators, cranking motors, generators, and regulators. The quantity of electronics now found on the modern vehicle requires that a new level of understanding of these systems is more important than ever. "The major failure of most machinery is in the electrical systems and the main electrical problem is still poor connections".

Safety and Supply Aspects:

* It is required that all students either wear their own prescription eyeglasses or safety glasses during all demonstrations and laboratory work. Safety glasses are available for purchase from the CWU Bookstore, Knudson Lumber, or Tum-a-Lum Lumber.

If any student is ever found not wearing their safety glasses, their grade will be reduced one letter grade and all work in the lab will stop for **all students** for the day!

* Although the Power Lab has a good number of tools, specialty tools or a good set of hand tools might make your day much smoother!

* Each student must provide their own:

- a. roll of shop towels (Al's, Car Quest, NAPA)
- b. shop apron, shop coveralls, shop overalls, or shop coat(used from Car Quest!)
- c. small tin cans, boxes, bags, or boxes to store parts and pieces

Course Text:

Required: Diagnosis and Troubleshooting of Automotive Electrical, Electronic, and Computer systems, James D. Halderman, Prentice-Hall

Recommended: Automotive Electrical Handbook, Jim Horner, HP Books

Course Outcomes:

At the conclusion of the course, students will be able to:

1. Explain the operation of the alternator, generator, cranking motor, regulator. The explanation will include nomenclature, current paths, materials composition, and critical voltages and currents.
2. Troubleshoot and perform failure analysis's on a generator and alternator. To include voltage output measurements, current measurements, field continuity, and diode tests.
3. Construct a test circuit for, and test, an electromechanical voltage regulator.

4. Operate, to the instructor's satisfaction, the armature lathe, armature tester, voltmeters, ammeter, ohmmeter, and diagnostic oscilloscope.
5. Perform load and specific gravity tests on storage battery electrolyte.
6. Design and fabricate a wiring harness.
7. Perform basic fabrication operations related to electrical systems.

Course Content Outline:

1. circuit tracing, troubleshooting, and wiring diagrams
2. electrical faults and basic test equipment
3. battery service
4. DC charging system inspection and testing
5. AC charging system inspection and testing
6. DC cranking motor theory and testing
7. Lighting and accessory systems theory

Course Assignments:

1. Two written examinations at 300 points each, for a total of **600 points**
2. Laboratory learning experiences, for a total of **400 points**
 - a. Fabricate a wiring harness and baseline fabrication exercises, **100 points**
 - b. complete restoration of an alternator, **100 points**
 - c. complete restoration of a cranking motor, or generator, **100 points**
 - d. complete load test and hydrometer test of a battery, **50 points**
 - e. complete a PC board-based electronic kit, **50 points**

All laboratory work will be graded on creativity, technical accuracy of your technical explanations, perseverance, workmanship, and cosmetic appeal

GRADING PROCEDURE:

The Course is designed around a system of 1000 points total. Each learning assignment has been weighted and assigned a certain portion of 1000 points based on: the amount of work required/creativity required/importance to professional development/relative value of cognitive vs psychomotor vs affective domains.

1. All assignments will be turned in on the day designated during the class time for the course. No grade will be given for late work !
2. No make-up assignments or examinations will be allowed except if provision for such circumstances is made in advance of the date in question.
3. All written work will be evaluated on the following criteria:
 - a. neatness
 - b. spelling
 - c. content quality
 - d. completeness
4. Please ask questions if assignments are unclear. The final responsibility for misunderstandings and late work rests with the student.
5. Points will be assigned for each student's work. The total points obtained throughout the course will then be evaluated according to the follow chart:

| | |
|---|---------|
| A | 100-90% |
| B | 90-80% |

| | |
|---|--------------|
| C | 80-70% |
| D | 70-60% |
| F | 60 and Below |

6. **Missing class is not OK.** Discussion, questions, safety instruction, and instruction on machines are all valuable and should not be missed. Absences cause expensive wear and tear on equipment, supplies, and facility. Demonstrations on equipment and technique cannot be given over.
7. Students are expected to perform ongoing cleaning and minor maintenance on equipment in the laboratory. Work areas should be straightened up and clean before leaving the Power Laboratory.
8. All written work will be typed or word-processed double-spaced, with 1" margins. Papers will be stapled in the upper left hand corner.
9. In those courses where laboratory work is done, cleanup assignments will be made. For each day that cleanup is not done completely, for whatever reason, one percentage point will be subtracted from the percent accumulated for a grade in the class.
10. Appointments can be made directly with Dr. Wieking. His Voice mail and Power Lab number are 963-1770.wiekingb@cwu.edu
11. "Close" grades will be determined by class attendance patterns, enthusiasm, and willingness to learn.

**Vehicle Electrical Systems
Course Schedule**

| Week # | Chapter/Topic | Assignment Due |
|---------------|---|---|
| 1 | Electrical theory, Chap #1 Electrical System Principles #2 Electrical Circuits and Ohm's Law | Background sheet |
| 2 | Electrical Theory, Battery Chap #1 Electrical System Principles #2 Electrical Circuits and Ohm's Law Batteries and Battery Testing | |
| 3 | #4 Electrical Test Equipment #9 Wiring, Circuit Diagrams, and Troubleshooting | |
| 4 | #11 Charging System, Chap Regulation | |
| 5 | #10 Cranking system Operation and Service | Exam #1 |
| 6 | | Fab and Harness due |
| 7 | | |
| 8 | | cranking motor or generator due |
| 9 | | alternator due |
| 10 | | * PC kit due last day of class * Exam #2 given during regular scheduled final exam day |

Vehicle Electrical Systems
Fabrication Assignment
Newest!!

An important part of this exercise is to plan the proper sequence of these operations so that all are possible!!!! Feel free to place items not specified, anywhere!

1. Cut a 6" square piece of cold-rolled steel sheet.
2. Solder a 1/2" square piece of sheet onto one corner of the 6" square, using rosin flux and the large soldering gun.
3. Bend a 1/4" flange on one edge of the square, using the cornice brake.
4. Rotex punch a hole, 1" or so in diameter.
5. Nibble a 1" square hole. This should be laid out with Dykem and machinist square first. File to your lines, with excellent finish.
6. Drill and tap an 8/32 hole. Screw one screw into it. Place this exactly in the middle of the 1/2" soldered square.
7. Acquire a 5" length of RG-59U coaxial cable. Strip and twist the ground. Strip back the center conductor back 1/2". Tin both conductors.
8. Drill and ream one 1/4" diameter hole. Use a twist drill the next undersize and then ream!
9. Use one rub-on word to label your steel square.
10. Use the flap wheel to dress all edges of your square.
11. Cut 5 pieces of wire 6" long. 2. Cut one of the pieces of wire and then splice it, using solder and one piece of shrink tubing. **Lace this harness**, using traditional waxed lacing cord, at 1/4" intervals.
12. Strip one wire end and then crimp a connector to it. Solder this connector.
13. Strip a 3/8" section of insulation from one of the wires and splice in a new short piece of wire.
14. Strip all the remaining wire ends and tin each.
15. Aircraft rivet, 2117 T-4, one crimp connector from your harness onto your square.
16. Form a circle with a 3" piece of ground wire. Solder the ends together, using a lap connection. Use the Weller soldering gun.
17. Place 6 electronic components onto a piece of scrap printed circuit board. Solder the components using the small pencil irons. You will need very fine solder for this operation !
18. Produce a 2" square PC board, using six pads and trace material. Then etch. This is called the "direct process". Finish by drilling each pad center with the Dremel Moto Tool and a #64 PC drill.
19. Cut a 1" square of 7075 T-0 Aluminum sheet and drill appropriately. Then use the arbor press to insert a NUTSERT into it. Drill a small hole into the square so that you can attach all of your work onto the 6" square.
20. Finish the surface of the 6" square using Scotchbrite in one direction only. Brush on sanding sealer.

Laboratory Learning Experience
Alternator Disassembly and Refurbishment

1. Remove the drive pulley. The air impact wrench works well. You may need the services of the pulley puller !
2. All of the alternator will be disassembled. Sketches, to be used for reassembly, are recommended here. I promise you that you will forget the details needed to reassemble your unit quickly and properly !
3. All shaft surfaces shall be polished with crocus cloth.
4. Aluminum die castings will be bead blasted. Don't use the wire wheel !
5. All windings shall be sprayed with insulating varnish. The heat gun will help the varnish to flow out and harden better... Remember that varnish has a tendency to "skin".
6. Smooth the slip rings with commutator paper.
7. Test the Rotor Winding and Field Winding with an ohmmeter.

a. continuity _____

b. grounds _____

a. continuity _____

b. grounds _____

8. Test the diodes (remember that they could be in the form of a diode trio).

| Forward Resistance | Reverse Resistance |
|---------------------------|---------------------------|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

9. You may need to retain the brushes out of the way with a paper clip when you reassemble the alternator.

Laboratory Learning Exercise
Cranking Motor/Generator Disassembly and
Refurbishment

Make sketches and notes for yourself! You will not remember how your unit is to supposed to go back together, otherwise! That is a promise!

1. Tear your unit down, washing all parts in solvent. **Do not** us any water or degreaser. You may need to scrape large amounts of residue into the garbage can first ! Use newspapers on your workbench to cut down cleanup time.
2. Polish all shafts with emery cloth and then crocus cloth.
3. Wire Wheel all threaded fasteners.
4. Test the armature with the armature tester.
5. Turn the commutator and polish it with commutator paper.
6. Paint the armature winding with Krylon insulating spray varnish. Mask off the laminated body and commutator.
7. Test field windings for:

Continuity _____

Shorts to ground _____
8. Paint the cranking motor exterior. Watch out for paint that could cause high-resistance connections.
9. You may wish to replace the brushes and bushings. Use our bushing driver--it is a beautiful tool.

Power Technology Laboratory Guidelines

RHWIEKING/2000

Dr. W believes that clean, orderly, organized, and well-maintained facilities are more enjoyable, accurate, and safe places in which to learn and work. Wieking considers The Power Lab as holy *ground*. You will be sharing this *spaceship* with a wide variety of fellow human beings!

1. **You** are responsible for cleaning the areas and machines in which you have worked.
2. Because of general CWU policy, there is no legal parking on the PTLB grounds. Campus police will ticket cars parked and not being worked on.
3. Cars that are to be worked on for class must:
 - a. Approach the Power Lab on the south-east wall.
 - b. Park perpendicular to the wall in a straight line.
 - c. Arrive no more than ten minutes before classes start.
 - d. Enter the Power Lab in a sequence dictated by Dr. W.

Wieking has no responsibility for, or authority over, the outside gravel area. He certainly cannot "fix" your parking tickets!

4. Report all bodily injuries to Dr. W immediately.
5. Report all damaged tools or equipment to Dr. W immediately. This may be done by you directly or "anonymously"!
6. Turn on vacuum cleaners to keep dust and Stoff out of the air.
6. Wear approved safety eye wear at all times in the main lab or clean room areas. W cares somewhat about your eye safety and a great deal about his eye safety! Safety glasses rules **are not enforced** to "mother" you, Big Brother you, protect the University, or the state, or the Governor, or even to protect you from yourself. Wieking must limit his exposure to legal liability in a court of law!
7. A face shield must be worn **over your approved safety eye wear** when operating these machines:
 - a. pedestal grinders
 - b. die grinder
 - c. valve grinders
 - d. vertical belt sander
 - e. pedestal wire wheel
 - f. pedestal flap wheels
 - g. milling machine
8. Run engines outside! If you must run one inside, make sure that rubber exhaust hoses are attached to the exhaust and that the suction fan is turned on!
9. Please never throw old oil outside in the vicinity of the Lab. Please do not spray paint outside so that paint gets on the surroundings!
10. All flammable liquids--gasoline, paint, oil, solvents and rags-- must be stored in appropriate containers. **No Loose cans of oil or solvent are to be left laying around!**
11. You are not allowed to use a piece of equipment until you have received training on that equipment.
12. All oil or water spills should be cleaned up immediately.
13. Wear either leather shoes or tennis shoes--no open toes or heels.
14. Tie back loose hair, jewelry, and clothing so that it will not be caught in spinning machinery.
15. Perform loud operations (air blast and die grinder) outside. Air blast out the west door, die grinder out the north door, on the work bench provided.
16. Wear appropriate, clean, and professional shop wear. It will increase the quality of your work and add to the Zen of all in which you are involved this quarter. Although dirty shop wear might show that you are fairly experienced, pretty hip,

and generally *with it*, Dr. W believes that dirty shop clothing does not reflect well on your professionalism and makes you a real fire hazard!