

MinE 682 – Mine Power Systems

Fall Semester, 2014

Tuesday & Thursday, 9:30 a.m. – 10:45 a.m., Room 109 MRB

- Instructor: Dr. Mark F. Sindelar, P.E.
Room 233 MRB (center office—in the Mine Design Lab)
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- Office Hours: Open Door Policy or by appointment
- Prerequisites: Phys 112, MinE 205, MinE 206, or Instructor Approval
- Required Texts: Morley, Lloyd A., 1981, Mine Power Systems, Volume I and Volume II, U.S. Bureau of Mines Open File Report (IC 9258), 1098 pages.

Mining Extension Service, West Virginia University, 1987, West Virginia Mine Electricians Reference Book/Study Guide, 94 pages.
- Reference Texts: Mileaf, Harry, ed., 1966, Electricity One-Seven, (New York, NY: Hayden Book Co.), any edition.

Ugly's Electrical References, 2011 edition (ISBN-13: 978-0-7637-9099-8) or 2014 edition (ISBN-13: 978-1-4496-9077-9).
- Introduction: This course provides the mining engineering student with the necessary knowledge, skills, tools, and ability to design a mine electrical power system. The course starts with basic DC and AC circuit analysis and elevates understanding to the power system design level by considering the contribution and characteristics of the physical elements required. The course provides the student with numerous practical applications of mathematics, mechanics, and engineering to solve problems and design sub-systems and complete systems related to mine power. In addition, safety, control, and troubleshooting topics relevant to mine electrical systems are be introduced to provide students entering the mining industry with an awareness of these critical issues.

Expected Learning Outcomes:

By the end of the course, students will be able to:

1. Analyze direct current (DC) circuits including calculations for voltage, current, resistance, and power.
2. Analyze single-phase and three-phase alternating current (AC) circuits including calculation of impedances, power factor (and power factor correction).
3. Specify an appropriate electrical motor for a given application including the size, voltage, torque characteristics, construction, starting, and overload protection requirements.
4. Use tables to size underground distribution cables appropriate for the given equipment including current rating, type of construction, and grounding and shielding requirements.
5. Understand the resistance grounded neutral power system used in underground mining, including its operation and characteristics including ground fault and ground monitor systems by appropriately sizing grounding conductors and grounding resistors, and specifying the design and operation of the ground fault detection and ground check systems.
6. Specify power centers and switch houses including transformer design and selection, KVA rating, circuits, fault protection, and power factor correction.
7. Correctly complete the “classic coal mine borehole diagram,” a pillar of Federal and State mine electrical qualification exams, and a good overview of the interrelation of electrical system components in mining.
8. Interpret the function of a simple relay control circuit (a foundation for PLC programming) to demonstrate understanding of the relaying and solid state equipment and used in mine power systems.
9. Calculate the capacities for battery operated mine equipment, given operating condition parameters.
10. Demonstrate the practical, legal, and economic constraints of mine power system design through development of the final project.
11. Identify key Federal and State regulations applicable to the design and operation of mine power systems.
12. Complete a single-line diagram for a typical mine including substations, switch houses, power centers, major equipment, major cables, voltages, ampacities, grounding, etc.

<u>Grading:</u>	Homeworks & Quizzes	40%
	Attendance / Participation	10%
	Special Topics Paper/Presentation	10%
	Mid-Term Exams	20%
	Final Project	20%

<u>Grade Assignment:</u>	100 – 90	A
	89 – 80	B
	79 – 70	C
	69 – 60	D
	59 - 0	F

- Attendance: It is expected that students will make every effort to attend class. Attendance will be taken and will be included in the Attendance/Participation component, which comprises 10% of the final grade. Students may be absent from class with pre-approval.
- Grading Policy: No make-up exams except by prior arrangement with instructor. Exam grading appeals must be submitted in writing on the day the exam is returned.
- HW Assignments: Homework assignments and or quizzes will be given approximately every week and each assignment will be worth approximately the same credit. The sum of the homework assignments, labs, and quizzes will be worth 40% of the class grade. Late assignments will not be accepted. The instructor will make every effort to thoroughly review all homework submissions that are presented in a neat, organized, and professional manner. Illegible, messy, or sloppy submissions will receive commensurate review.
- Quizzes: Short quizzes to judge student preparedness and understanding will be given frequently throughout the class. Some quizzes will be announced; some quizzes will be unannounced. No make-up quizzes except by prior arrangement with the instructor. The sum of the homework assignments, labs, and quizzes will be worth 40% of the class grade.
- Labs: Due limitations of the class size and the classroom setting, labs will consist of demonstrations with follow-up assignments that reinforce the concepts. The sum of the homework assignments, labs, and quizzes will be worth 40% of the class grade. Late assignments will not be accepted and labs will not be repeated outside of class.
- Final Project: A final design project will be given to each individual student at the mid-point of the term. The project will essentially consist of developing a comprehensive single-line electrical diagram of a typical mine with appropriate supporting documentation and calculations. The final project will be due the week before Dead Week, and will be worth 20% of the final grade.
- Special Topics
Paper/Presentation: The student will submit a short paper on a special topic (*e.g.* variable frequency drives) and possibly make a short presentation on this subject to the MinE 382 Mine Power Systems class. This paper will be assigned near the mid-point of the term.

Attendance Policy: Consistent with WVU guidelines, students absent from regularly scheduled examinations or quizzes because of authorized University activities will have the opportunity to take them at an alternate time. Make-up exams or quizzes for absences due to any other reason will be at the discretion of the instructor.

Classroom Conduct: Since you are all professionals in training, I expect you to conduct yourself in a professional manner in this class. For instance, when the class is in progress, I expect everyone to remove their hats, put away the newspaper, turn off all electronic devices (*e.g.* cell phones), and refrain from eating, drinking, or smoking. Please do not force me to have to remind you that you should behave in a professional manner. Disruptive and unprofessional behavior will result in an unfavorable "Participation" component of your grade. Everyone is encouraged to ask questions and share personal experiences regarding electrical systems with which you have familiarity.

Professional
Registration:

As part of the academic and professional development of young mining engineers, the Mining Engineering Department strongly encourages student to take the Fundamentals of Engineering (FE) exam and to then follow this by becoming registered as a Professional Engineer (PE).

Social Justice
Statement:

The following statement has been approved by the Faculty Senate to replace the previously existing Social Justice and Disability Statement. Faculty members are encouraged to include this statement in their syllabi. Although its inclusion is not mandatory, if a faculty member wishes to include a statement to this effect, it must be the following, Faculty Senate-approved statement:

"The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion.

If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me and make appropriate arrangements with the Office of Disability Services (293-6700). For more information on West Virginia University's Diversity, Equity, and Inclusion initiatives, please see <http://diversity.wvu.edu>."

Days of

Special Concern:

WVU recognizes the diversity of its students and the needs of those who wish to be absent from class to participate in Days of Special Concern, which are listed in the Schedule of Courses. Students should notify their instructors by the end of the second week of classes or prior to the first Day of Special Concern, whichever is earlier, regarding Day of Special Concern observances that will affect their attendance. Further, students must abide by the attendance policy of their instructors as stated on their syllabi. Faculty will make reasonable accommodation for tests or field trips that a student misses as a result of observing a Day of Special Concern.

Academic Integrity:

As a future professional, your academic and personal integrity is assumed. The WVU academic guidelines may be found at <http://www.arc.wvu.edu/admissions/integrity.html>

Tentative Course Schedule:

Week	Topic
1	History and Evolution of Mine Power Systems, Electrical Safety
2	Electrical Theory, DC Circuit Analysis (KVL, KCL, Ohm's Law)
3	DC Network Analysis and Applications, Batteries
4	Phasor Domain, Impedance, AC Single-Phase Circuit Analysis
5	AC Network Reduction, RMS, Power Factor Correction
6	AC Three-Phase Circuits, Transformers, 3- ϕ pF Correction
7	Exam 1, 3- ϕ Transmission
8	Three-phase faults, Rotating Machines I
9	Rotating Machines II (generators and motors)
10	Distribution, Single Line Diagram, Load Factor System
11	Mine Power Cables, Splicing, Full-load Current Designs, Permissibility, MSHA and State Regulations for Mine Electrical Systems
12	Substations, Introduction to Grounding
13	Grounding and the Safety Grounded System
14	Relay Control, PLCs, and Solid State Applications, Exam 2
15	(Thanksgiving Holiday—no class)
16	Lightning and Lightning Protection
17	Review Final Projects, Current Topics in Mine Electrical Systems

In addition, some “special topics” will be introduced as schedule allows.