EE223 Electrical Circuit Analysis II Spring 2024

Catalog Description Electrical Circuit Analysis II is the second course in a series designed to provide engineering majors the tools to analyze and design passive analog circuits. This course introduces capacitors and inductors, and develops the natural and forced responses of first and second-order circuits containing these elements. It introduces complex phasor notation in the context of sinusoidal steady-state analysis, and then further develops these concepts in the analysis of single and three-phase AC power systems. The laboratory portion of the course introduces the practical skills of designing, building, and debugging physical circuits in the context of relevant contemporary examples. It includes a major design 4-lab sequence in which cadets design and build a project of their choice. Required course.

Prerequisites MA124, C or better in EE122. Corequisite: MA 311.

Textbook

Required: Create Text, ISBN: 9781307563177, based on excerpts from *Fundamentals of Electric Circuits* by Alexander & Sadiku, 7th ed., McGraw Hill. I strongly recommend that you purchase the book from the bookstore or direct from McGraw Hill. I recommend not purchasing the book used or from a third-party bookstore since these do not come with the required Connect Access number needed for the homework and tests. If you do so anyway, there are ways that you can purchase the Connect code direct from McGraw Hill, but many students have had trouble doing this in the past and have ended up purchasing the textbook twice as a result. This text and Connect Access code is for both EE223 AND EE230, so do not sell it after this semester. You may purchase it either in the bookstore or online from this link: http://shop.mheducation.com/mhshop/connect/productDetails?isbn=1266132430, which is also on the Canvas page. Many of the homework assignments use Connect Access; you will get zeros for these assignments if you elect not to purchase Connect Access. It does comes with a two week grace period before it requires a purchase code.

Optional: *FE Handbook*, available from www.ncees.org, $14.
LTSpice, free (Google it)
Matlab, free (Barracks Help Desk). You can also install it yourself from anywhere in the world using a slightly more complex process: first, register with Mathworks (https://mathworks.com, person icon in top right), then install it on your computer from here: https://vmiengineering.github.io/matlab.html. In a pinch you can access a stripped down version that is entirely web-based at https://matlab.mathworks.com/, although this version will have limitations that make it less ideal than the full version.

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Office hours: **The best way to reach me is by email, and you will find me *very* fast to respond.** If you need to schedule a face-to-face appointment, first email me three choices of times you are free the following day, and I will select one. If you do that, please include in your email the reason for the meeting; often I can solve the problem immediately before we would have otherwise even found a future time to meet, and if not I can prepare materials for our meeting to make it more efficient.

Course schedule (3) 50 minute lectures and (1) two-hour laboratory each week

Class:	NEH 428	MWF	0900 – 0950
Lab:	NEH 428	T	1250 – 1440

Course Objectives[1]

1. Develop a basic intuition and ability to quantitatively analyze first-order and second-order circuits and non-electrical systems as linear constant coefficient differential equations [A,B,C]
2. Develop the skills necessary to design AC and transient circuits to solve real-world, relevant problems [A,B,C,E]
3. Develop laboratory skills to build, test, and debug moderately complex DC and AC networks [A,B,C,D,E]
4. Develop individual and team working and communication skills [B,C,D]

[1] Letters in brackets correspond to Electrical Engineering program objectives

Performance Criteria

for Objective 1:

a. Students will be able to explain how voltage and current are related for capacitors and inductors, both from intuitive and quantitative viewpoints.
b. Students will be able to model non-electrical engineering phenomena using electrical engineering analogs (e.g. mechanical, hydraulic and thermal analogies)
c. Students will be able to analyze the response of circuits containing resistors, capacitors, and inductors to transient inputs including steps, exponential decays, and sinusoids
d. Students will be able to analyze the response of circuits containing resistors, capacitors, and inductors to sinusoidal steady-state inputs
e. Students will be able to use computer-aided design tools including Spice and Matlab to analyze and test circuits they have designed

for Objective 2:

a. Students will be able to design circuits using resistors, capacitors, and inductors to meet given criteria
b. Students will design and construct DC and AC circuits that perform real-world, relevant operations such as digital to analog conversion, transducer signal conditioning, and acoustic heartbeat monitoring
c. Use complex exponentials to represent input sinusoids
d. Calculate the RMS power delivered by arbitrary single phase sources
e. Explain why it is desirable to have unity power factor and be able to design circuits to achieve this in a given inductively-loaded power distribution system
f. Analyze and design AC circuits that include transformers
g. Explain the difference between balanced and unbalanced three phase networks

for Objective 3:

a. Use lab instruments including DMMs, oscilloscopes, frequency generators, and power supplies
b. Students will be able to construct moderately complex DC and AC circuits using prototyping stations
c. Students will be able to debug circuits using a modular approach

for Objective 4:

a. Students will demonstrate the ability to prepare and deliver extemporaneous briefings to the class explaining how particular problems were solved
b. Students will demonstrate the ability to communicate effectively via written and oral means by submitting a proposal with design specifications for a project of their own choosing, and by delivery of a rehearsed oral presentation summarizing their project results
c. Students will work in small laboratory teams and be able to document their laboratory work

Topics

Energy-storage elements (chap 5)
- Capacitors
- Inductors
- DC steady state performance

First-order circuits (chap 6)
- source-free response
- unit step response
- examples

Second-order circuits (chap 7)
- Source-free response
- Unit step response
- examples

Sinusoidal sources and phasors (chap 8)
- Properties & RLC circuit example
- Complex sources
- Phasors

AC steady-state analysis (chap 9,10)
- Circuit simplifications
- Nodal & mesh analysis

AC steady-state power (chap 11)
- Average power
- RMS values
- Complex power

Three-phase circuits (chap 12)
- Three phase balanced systems

Grading

Component	Percent
Homework and labs	15
Test 1	20
Test 2	20
Test 3	20
Final exam	25
Total	100

Homework Homeworks are to be done individually. There is on average one graded assignment each week, submitted through various means (paper, McGraw-Hill Connect online, Canvas online). I will drop the lowest homework grade before assigning the final grade, but not for the midterm grade, so if you omit one it will not affect your grade. **You must acknowledge help from all sources (excluding myself and your textbook) including classmates, other professors, other cadets' notes, old homework solutions, and books.**

Laboratories Laboratory packets are available for download on the course Canvas website; these include both a prelab component ("prelab") and a post-lab write-up ("lab report"). The prelabs must be completed individually, and must be ready by the start of the lab. Select one lab partner (there may be one group of 3 students) for the in-class lab and for help writing your lab report, which is due at the start of class on that Friday. The lab report, unlike the prelab, is one report per lab team. In summary, a lab of 20 students should have 20 individually-done prelabs ready at the start of the lab, and 10 lab reports handed in at the start of Friday's class. **If you show up to lab without completing the pre-lab, you will be turned away because you need your prelab values to complete the lab. The prelabs are not short assignments; if you choose to start working on the prelab on the morning of the lab, you are choosing to not complete the lab on-time.**

Late policy Graded requirements are due at the start of class. The only authorized exceptions are by direction of the superintendent, hospitalization, or in the case of extenuating circumstances, by ***prior*** arrangement with me. Attending a scheduled guard duty does not exempt a cadet from turning in the assignment to me, either directly (under my door in advance of the class) or to a classmate to turn in on-time. I do not accept late homework assignments; late lab reports start at 80%. We have many homework assignments, and I understand life can interfere; I drop the lowest HW grade.

Tests Tests are closed book and closed notes, however you may hand-write (not photocopy) notes onto both sides of a 3x5" notecard for each test. Calculators are authorized for all homework, quiz, and examination problems. I recommend purchasing a TI-86 or higher to see you through EE223 and the remaining engineering courses at VMI.

Professional Component 4 credits of Engineering Topics (specifically, Engineering Science and Design)

Relationship Of Course To Program Outcomes primarily department program outcomes 1, 5, 11, 13, 14 and 15.

Prepared by COL James C. Squire, 01/6/24

Appendix A: Institute Work For Grade Policy

"**Work for grade**" is defined as any work presented to an instructor for a formal grade or undertaken in satisfaction of a requirement for successful completion of a course or degree requirement. All work submitted for grade is considered the cadet's own work. "**Cadet's own work**" means that he or she has composed the work from his or her general accumulation of knowledge and skill except as clearly and fully documented and that it has been composed especially for the current assignment. No work previously submitted in any course at VMI or elsewhere will be resubmitted or reformatted for submission in a current course without the specific approval of the instructor.

In all work for grade, failure to distinguish between the cadet's own work and ideas and the work and ideas of others is known as **plagiarism**. Proper documentation clearly and fully identifies the sources of all borrowed ideas, quotations, or other assistance. The cadet is referred to the VMI-authorized handbook for rules concerning quotations, paraphrases, and documentation.

In all written work for grade, the cadet must include the words "**HELP RECEIVED**" conspicuously on the document, and he or she must then do one of two things: (1) state "none," meaning that no help was received except as documented in the work; or (2) explain in detail the nature of the help received. In oral work for grade, the cadet must make the same declaration before beginning the presentation. Admission of help received may result in a lower grade but will not result in prosecution for an honor violation.

Cadets are prohibited from discussing the contents of a quiz/exam until it is returned to them or final course grades are posted. This enjoinder does not imply that any inadvertent expression or behavior that might indicate one's feeling about the test should be considered a breach of honor. The real issue is whether cadets received information, not available to everyone else in the class, which would give them an unfair advantage. If a cadet inadvertently gives or receives information, the incident must be reported to the professor and the Honor Court.

Each cadet bears the responsibility for familiarizing himself or herself thoroughly with the policies stated in this section, with any supplementary statement regarding work for grade expressed by the academic department in which he or she is taking a course, and with any special conditions provided in writing by the professor for a given assignment. If there is any doubt or uncertainty about the correct interpretation of a policy, the cadet should consult the instructor of the course. There should be no confusion, however, on the basic principle that it is never acceptable to submit someone else's work, written or otherwise, formally graded or not, as one's own.

The violation by a cadet of any of these policies will, if he or she is found guilty by the Honor Court, result in his or her being dismissed from VMI. Neither ignorance nor professed confusion about the correct interpretation of these policies is an excuse.

Appendix B: Department Work For Grade Policy

Tutoring [e.g. Writing Center, Academic Center, athletic tutors, private tutors]: The ECE Department supports and encourages cadet use of such learning aids, as offered by the VMI Writing Center, VMI Academic Center, and tutors. All assistance from these, and any other similar aids, must be explicitly described in the cadet statement regarding HELP RECEIVED.

Peer Collaboration: Peer collaboration policies, including policies on CRITICAL COMMENTS, will be established by the individual faculty of the ECE Department, and may vary from assignment to assignment. Each ECE faculty member will clearly indicate the appropriate collaboration policy for each assignment. Policy regarding laboratory groups, team cooperation, interaction between teams, etc. will be established by the individual faculty. All assistance from such peer collaboration must be explicitly described in the cadet statement regarding HELP RECEIVED.

Computer Aids [including calculators, translators, spelling, style, and grammar checkers]: The ECE Department supports and encourages cadet use of computer aids, including calculators, translators, spelling, style, and grammar checkers to improve the quality of the cadets' work. The use of such computer aids does not constitute HELP RECEIVED.

Appendix C: Disability Policy

VMI abides by Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 which mandate reasonable accommodations are provided for all cadets with documented disabilities. If you have a registered disability and may require some type of instructional and/or examination accommodations, please contact me at least 72 hours before examinations to request special accommodations. If you have not already done so, you will first need to register with the Office of Disabilities Services, the designated office on Post to provide services for cadets with disabilities. The office is located on the 2nd floor of the VMI Health Center. Please stop by the office of the Director of Disabilities Services, for more information