ECE 2100 Circuit Analysis

Fall 2022

version 3 October 2022

Instructor
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Course Format Summary

This is only a summary; details are provided within this document.

Due dates will be strictly enforced this semester.
Late assignments will not be accepted without prior approval (as possible) and official documentation.

Lecture.

- This is an in-person class, though previously recorded lectures on the course material are available on ELearning. CRITICAL NOTE: These recorded lectures ARE NOT a substitute for class attendance. Binge watching lectures WILL NOT prepare you for the lab or examinations. The recorded lectures are for students that must miss a few classes and provide an opportunity to review course material. There are a few recorded lectures that provide material not covered in lecture as noted in the course schedule.
- You should attend all in-person lectures (note the possibility of unannounced quizzes).
- Homework is via the online McGraw-Hill connect® system.
- Exams will be conducted in-person during the scheduled lecture and final exam times.
- Dr. Miller is available in his office during office hours as posted here.

Laboratories

- In-person lab attendance is MANDATORY during the assigned meeting time. See the course schedule. Lab reports will not be accepted from students that do not attend the associated lab session.
- Lab reports and supporting work is submitted via ELearning to your lab instructor.

Note

This syllabus provides a detailed course schedule from which supplemental materials (e.g. lab handouts and previous exams) can be downloaded.

Office Hours

Dr. Miller is available for in-person office hours as posted in his schedule. Appointments at other times are requested by email to damon.miller@wmich.edu.

Laboratory Sections
Laboratory sessions and laboratory instructor office hours are held in the Electrical Circuit[s] Laboratory, Room B-215, Floyd Hall.

MEETING TIME	INSTRUCTOR	EMAIL	OFFICE HOURS (start 2nd week of semester)
M 6:30PM-9:10PM	Himanaga Emani	h.emani@wmich.edu	F 2-4PM
T 8:30AM-11:10AM	Himanaga Emani	h.emani@wmich.edu	F 2-4PM
T 2:30PM-5:10PM	Jadon Clugston	jadon.j.clugston@wmich.edu	W 3-5PM
T 6:30PM-9:10PM	Valliammai Palaniappan	valliammai.palaniappan@wmich.edu	F 2-4PM
W 6:30OM-9:10PM	Valliammai Palaniappan	valliammai.palaniappan@wmich.edu	F 2-4PM
R 8:30AM-11:10AM	Himanaga Emani	h.emani@wmich.edu	F 2-4PM
R 6:30PM-9:10PM	Jadon Clugston	jadon.j.clugston@wmich.edu	W 3-5PM

Tutors
Please visit https://wmich.edu/step/successcenter for tutoring services.

Catalog Description
ECE 2100 Circuit Analysis (3-3), 4 hrs. Analysis of linear electric circuits using methods based on Kirchhoff's laws and network theorems. RL, RC, and RLC transients. Sinusoidal steady state analysis. ***Prerequisites:*** PHYS 2070 (or taken concurrently) and MATH 1230 or 1710; with a grade of "C" or better in all prerequisites.

Acknowledgements
ECE faculty members, including S. Durbin, J. Gesink, J. Kelemen, and F. Severance, contributed to course materials, including the course syllabus. Dr. Miller thanks current and past laboratory instructors that have provided improvements to this course. He also thanks Instructional Designer M. Strock and the Educational Technology Department for contributions to course materials, including this syllabus.

Course Overview
This course explores the analysis of linear circuits for constant (DC) and time-varying (AC) excitation using methods based on Ohm's Law, Kirchhoff's Voltage Law (KVL), Kirchhoff's Current Law (KCL), and network theorems. Transient responses of first and second-order circuits are found by solving differential equations. Particular emphasis is placed on using complex numbers (phasors) to analyze circuits in the sinusoidal steady state owing to the importance of sinusoids in electric power distribution and electronic circuit design. Students move from analysis to the design of practical circuits including voltmeters, ammeters, and filters. Operational amplifier applications are explored in lecture and lab. The course includes hands-on learning via a rigorous laboratory experience and extensive use of circuit simulation software.

Course Objectives
This course explores

1. Electric charge, current, voltage, energy, and power;
2. Analysis of linear DC circuits using Ohm's law, Kirchhoff's Voltage Law (KVL, mesh analysis), and Kirchhoff's Current Law (KCL, nodal analysis);
3. Network analysis techniques including superposition, source transformations, and Thevenin and Norton's theorems;

4. Design of DC voltmeters and ammeters using d'Arsonval movement meters;
5. Analysis and design of electronic circuits, including amplifiers and filters, that utilize operational amplifiers;
6. Terminal characteristics of capacitors and inductors;
7. Analysis of steady state linear AC circuits containing dependent and independent sources, resistors, capacitors, and inductors;
8. DC and AC power calculations including power factor correction;
9. Determining the step response of first and second order linear circuits;
10. Representing the step response as a sum of a transient and steady state response and a natural and forced response;
11. Analysis, simulation, and experimental validation of DC circuits;
12. Analysis and simulation of AC circuits;
13. Use of test instrumentation such as voltmeters, ammeters, ohmmeters, signal generators, and oscilloscopes;
14. Thorough and accurate documentation of laboratory work using a laboratory notebook;
15. Thorough and accurate documentation of laboratory results using a laboratory report; and
16. Functioning as an effective engineering team member.

Textbook and Materials

Lecture
Required:
You need the **text** and access to the **online McGraw-Hill Education connect® system**.

1. **Text:** C. K. Alexander and M. N. O. Sadiku, *Fundamentals of Electric Circuits*, McGraw-Hill Education, 7th edition.
2. **McGraw-Hill connect® system access**
   You have several options for obtaining these materials:

   a. All digital option: Alexander and Sadiku eBook and connect® access card (Alexander), available from bookstore. ISBN-13: 9781264272686
   b. All digital option: Alexander and Sadiku eBook and connect® access (Alexander) card. Purchase access card with eBook when you register for connect® access via the provided registration link (below). Price will be higher if you purchase from the ‘general’ McGraw-Hill website, so use the registration link.
   c. Loose leaf Alexander and Sadiku text with connect® access (Alexander) card, available in bookstore. ISBN-13: 9781264272648

   On-Line Homework Student Registration Information:
   Course: ECE 2100 Circuit Analysis
   Instructor: Damon Miller
   Section: Fall 2022
   Online Registration Instructions:
   https://connect.mheducation.com/class/d-miller-fall-2022-2
   Note that your homework assignments are stored on a non-WMU server. Do not provide confidential information such as your WIN number. If you wish to keep your homework scores anonymous on that server, as far as the instructor is concerned, you do not have to use your wmich.edu email address as your ID; in that case, you may use an alternative ID, but you must notify the course instructor.

Laboratory

Required:

3. J. Kelemen, D. A. Miller, F. L. Severance, S. Durbin, et al., *ECE 2100 Laboratory Manual*. This manual is accessible online as individual links **within the course schedule at the end of this document**. It is your responsibility to check the manual for updates as the semester progresses.
4. Digital multimeter (or equivalent): DIGITAL MUTLIMETER SKU 01DMMS8269
5. Safety glasses meeting ANSI Z87.1, e.g. SAFETY SPECTACLE - DELUXE: SKU 060373
   Glasses must have side protection.
   Students will not be admitted to the lab without safety glasses.
6. Linear Technology**,** *LTspice*®, available at no cost at http://www.linear.com/designtools/software/. This software will be used to simulate circuits. You are responsible for ensuring access to a working copy.

   SPICE EXAMPLES

   a. VCCS example (problem 4.43 from Nilsson and Reidel, *Electric Circuits*, 8th ed.)
   b. CCCS and CCVS example (problem 4.51 from Nilsson and Reidel *Electric Circuits*, 8th ed.)
   c. VCVS example (simple operational amplifier model)
   d. Chua's "Simple" Chaotic Circuit (need the National Semiconductor LM741 model available as part of laboratory six in the course schedule below.

7. You must maintain a **laboratory notebook** (permanently bound, not loose leaf, 8.5 inches x 11 inches, 60 pages minimum, quadrille ruled, each page has a square grid, no carbon paper pages) to record your laboratory work. Use a pen to record your work (not a pencil); simply cross-out, but do not obliterate, mistakes. This National Engineering and Science Notebook is a good choice.
8. Ruler
9. Calculator
10. Bring your text to lab.

References (also see course schedule):

1. J. W. Nilsson and S. A. Riedel, *Electric Circuits*, 10th ed., Pearson, Boston, 2015.
2. M. M. Radmanesh, *Electronic Waves & Transmission Line Circuit Design: Your Illustrated Guide to Wave Engineering*, AuthorHouse, 2011.
3. W. H. Middendorf and R. H. Engelmann, *Design of Devices and Systems*, Marcel Dekker, 3rd ed., 1998.
4. J. A. Cadzow and H. F. Van Landingham, *Signals, Systems, and Transforms*, Prentice-Hall, Inc., New Jersey, 1985.
5. B. Lojek, *History of Semiconductor Engineering*, Springer-Verlag, 2007.
6. A. S. Sedra and K. C. Smith, *Microelectronic Circuits*, 4th ed., Oxford University Press, 1998.
7. Weisstein, Eric W. "Fourier Series--Square Wave." From *MathWorld*--A Wolfram Web Resource. http://mathworld.wolfram.com/FourierSeriesSquareWave.html
8. J. L. Kirtley Jr., *AC Power Flow in Linear Networks*, copyright date 2007, available here.
9. Kennedy, M.P., "Three Steps to Chaos. I. Evolution," IEEE Transactions on Circuits & Systems I-Fundamental Theory & Applications, vol.40, no.10, pp.640-656, 1993.
10. Kennedy, M.P., "Three Steps to Chaos. II. A Chua's Circuit Primer," IEEE Transactions on Circuits & Systems I-Fundamental Theory & Applications, vol.40, no.10, pp.657-674, 1993.
11. L. Chua (ed), G, Sirakoulis (ed), and A. Adamatzky, *Handbook of Memristor Networks*, Springer, 1st ed., 2019.
12. L. O. Chua, "The Genesis of Chua's Circuit," *Archiv fur Elektronik und Uebertragungstechnik*, vol. 46, no. 4, 1992. Available here.

13. D. A. Miller and G. Grassi, "Experimental realization of observer-based hyperchaos synchronization," *IEEE Transactions on Circuits and Systems-I: Fundamental Theory and Applications*, vol. 48, pp. 366-374, March 2001.
14. S. H. Strogatz, *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and* Engineering, Westview Press, 2nd ed., 2015.
15. E. Scheinerman, *Invitation to Dynamical Systems*, Prentice Hall, 1996.

Recommended:

1. The Rose-Hulman Institute of Technology has an excellent interactive "Circuits Learned by Example Online" website that includes mini-lectures on how to work many types of circuit analysis problems: http://www.rose-hulman.edu/CLEO/
2. http://www.allaboutcircuits.com/
3. http://falstad.com/circuit/

COURSE POLICIES

Academic Honesty

General:

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/index.php?catoid=35 and the Graduate Catalog at http://catalog.wmich.edu/index.php?catoid=39. 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 http://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 http://www.wmich.edu/conduct
- Division of Student Affairs http://www.wmich.edu/students/diversity
- Registrar's Office http://www.wmich.edu/registrar/calendars/interfaith
- Disability Services for Students http://www.wmich.edu/disabilityservices.

— section provided by the WMU Faculty Senate with minor link reformatting

Plagiarism: For an in-depth exploration of plagiarism, see http://libguides.wmich.edu/plagiarism

COVID-19: See https://wmich.edu/covid-19 for current WMU policies.

Accommodations

If you have a documented disability and verification from the Disability Services for Students (DSS), and wish to discuss academic accommodations, please contact your instructor as soon as possible. It is the student's responsibility to provide documentation of disability to DSS and meet with a DSS counselor to request special accommodation before classes start.

Grading Basis

1. Examinations (2 in-semester exams plus final): 60%
   Final counts as two in-semester exams.
   Due to the class size requests for examination rescheduling cannot be approved though religious observances will be accommodated with advanced notice.
2. Homework and Quizzes (announced and unannounced): 10%
   There are unlimited submission attempts for the online homework assignments; the highest grade is used.
3. Laboratory: 30%
   Students earning less than 70% in the lab will be assigned an 'E'.

OUTSTANDING WORK might earn extra credit. The first student to report an error in any material prepared by the instructor(s) will earn extra credit. The course grading scale is:

Scale: 0-59 E | 60-64 D | 65-69 DC | 70-74 C | 75-79 CB | 80-84 B | 85-89 BA | 90-100 A |
Numeric scores are rounded to the nearest integer.

A grade of 'X' will be assigned to any student that earns an 'E' and does not complete all examinations including the final.

Midterm grades are not assigned.

Viewing Grades
Homework grades are available via the McGraw-Hill connect® website. It is your responsibility to monitor your online scores to insure you received proper credit.

Grade Appeals
If you have a question regarding graded course materials (e.g. exam problems, homework problems, laboratory reports, etc.), contact Dr. Miller within **TWO** business days of receiving the grade for the assignment in question.

Late Assignments will not be accepted without a documented excuse. If an emergency prevents you from submitting an assignment on-time, contact your instructor PRIOR to the assignment due date or as soon as you can, via email. Failure to adhere to this policy will result in zero credit for the assignment.

EXAMINATIONS will be closed-notes closed-book. All electronic devices, including watches, must be stowed away. You must have a WMU issued ID with you at the exam. If you observe an apparent incident of academic misconduct, please confidentially alert the course instructor.

Students that exit the exam area during the examination period may not resume taking the exam upon their return. Please address any personal issues prior to the exam session.

Only under extremely unusual circumstances will make-up examinations be considered. If an emergency prevents you from attending a scheduled examination or quiz, contact Dr. Miller via email PRIOR to the test or as soon as you can. Failure to adhere to this policy will result in zero credit for the exercise.

LABORATORY

Lab attendance is mandatory.

Students must successfully complete the laboratory safety quiz prior to performing any ECE 2100 experiments. Any indication of failure to follow safe laboratory procedures will result in removal from the lab and course failure.

Only under extremely unusual circumstances will make-up laboratories be considered. Religious observances will be accommodated with advanced notice. If an emergency prevents you from attending a laboratory or arriving on-time, contact your lab instructor via email PRIOR to the lab or as soon as you can. Failure to adhere to this policy will result in zero credit for the lab. Joining or arriving late to lab (i.e. after the posted start time) without a valid excuse may result in zero credit for that lab. *There is no obligation to provide makeup lab sessions for unexcused tardy or absent students*. Students must obtain email approval from Dr. Miller prior to making up a lab.

Grading Basis

Your laboratory grade will be determined using the following evaluation criteria:

1. Pre-lab quizzes (20%). Quizzes are closed book; however, you may use your laboratory notebook on quizzes. Potential sources of quiz questions include previous labs and the current pre-lab assignment and may require calculations.
2. Lab reports (80%).
    a. Unless otherwise noted, each lab team submits one report.
       ECE 2100 LABS ARE COMPLETED INDIVIDUALLY OR IN TEAMS OF TWO.
       No three-person teams.
    b. **USE A WHITE BACKGROUND FOR ALL LTspice® schematics and waveform plots.** Reports must not be handwritten, though you must include copies of your hand-written lab notebook as an appendix.
    c. It is essential that whenever possible *hand analysis*, *simulation*, and *experimental* results be presented side-by-side (using tables or graphs) and errors between these results be quantitatively described. Explain discrepancies.
    d. Whenever possible, present your results in graphical form. One approach is to plot hand analysis and experimental results on top of graphs obtained via simulation. Plot the independent variable along the abscissa and dependent variable(s) along the ordinate. **Do not 'connect-the-dots,' that is, do not connect experimental points with "best-guess" curves unless there is a valid reason for doing so.**
    e. Tables are another effective method of organizing and presenting results.

Your lab report describes ALL OF YOUR LAB WORK and is a STAND-ALONE DOCUMENT, including any LTspice® schematics/results (those can be pasted from LTspice® into a document editor by using 'Tools->Copy bitmap to Clipboard'). The lab report is organized as follows. Use separate section headings for each item.

1. **Title page**

Team Member #1 Name
Team Member #1 Major

Team Member #2 Name
Team Member #2 Major

ECE 2100 Laboratory Report

Title of Experiment
Date Laboratory was Performed

Name of Laboratory Instructor
Day/Time of your lab section

2. **Summary (on separate page):** Brief but complete statement of what you did.

Example:
The complex power of a series-connected ??? Ω resistor (R) and ??? H inductor (L) operating at 60 Hz was investigated. The complex power was determined to be 100 + 100j VA by hand analysis and simulation. Addition of a ??? uF capacitor connected in parallel to the RL load resulted in a unity power factor in both hand analysis and simulation work.

3. **Prelab:** Include the prelab results here after correcting any errors. Whenever possible present results in tabular form. If there is not a prelab assignment include simply indicate N/A in this section. Only one prelab per report, even if the prelab was completed individually.
4. **Results:**
    a. Present your results keyed to each step of the laboratory procedure. Include schematics, sketches, plots, etc.
    b. Describe what was done and document your results.
5. **Analysis:** Provide response(s) to any end-of-lab questions. If none simply indicate N/A in this section. Only one analysis section per report.
6. **Contributions:** List the contributions of each team member to completion of the experiment and report.
7. **Conclusions:** Describe lessons learned.
8. **Lab Notebook:** Attach the related lab notebook pages as an appendix FOR EACH TEAM MEMBER. Team members with poor notebook entries will be penalized.

Style
Observe proper sentence structure, spelling, and punctuation. Use third person, passive voice. Avoid repetition, the obvious, abstractions, and wordiness.

Submission
Unless otherwise noted, each lab team submits ONE PDF report and ONE ZIP file containing supporting files; only one team member submits these two items.

1. Submit your REPORT as a single PDF file to your lab instructor's ELearning Dropbox by the indicated due date for that lab. Name the file as follows:

   "LastNameFirstName_Report_Lab#_SessionDayAndTime"; for example,
   DoeJane_Report_Lab8_R830.pdf

   is Jane Doe's report submission for her Thursday 8:30 lab team for Lab 8. The lab report is a stand-alone document and includes all of your work, including LTspice® schematics and simulation results.

2. Submit all SUPPORTING FILES (e.g. ALL LTspice® files) used in your lab work to your lab instructor's ELearning Dropbox by the indicated due date for that lab as a single ZIP file. Name the file as follows:

   "LastNameFirstName_SPICE_Lab#_SessionDayAndTime"; for example, "DoeJane_SPICE_Lab8_R830.zip"

   is Jane Doe's supporting files submission for her Thursday 8:30 lab group.

   Submissions not following these instructions will not be accepted.

3. Lab notebook (part of lab reports grade) You must also maintain a laboratory notebook. Lab notebooks provide a convenient and professional method of organizing and storing your lab work and records. Your laboratory notebook will be evaluated for neatness, organization, technical accuracy, and completeness as part of your lab report submission. Specific guidelines for the notebook will be provided in the laboratory.

   Each laboratory must be initialed by the lab instructor. Signatures will be made in only two cases:
   a. The laboratory is complete including the results section (LAB COMPLETE signature);
   b. The lab session is over (IN PROGRESS signature). For this case a second LAB COMPLETE signature is required by the end of the next lab session.

   Lab reports without signed-off notebook pages will not be accepted.

HOMEWORK
Homework assignments are via the online McGraw-Hill connect® system. Due dates are posted in the course schedule. It is your responsibility to monitor your online homework scores to ensure that you have received proper credit.

If you believe that there is an error in an online problem solution, submit that problem to Dr. Miller before the assignment due date via email. Include complete documentation (e.g. circuit diagrams) and a printout of the online solution with error(s) identified. Clearly show how you arrived at your solution. If there is an online homework system problem that precludes you from an on-time assignment submission, contact the instructor prior to when the assignment is due.

Tentative Course Schedule
The schedule will be frequently updated as the semester progresses.
Yellow highlight indicates item requiring future attention

#	date	topic (KEYED TO ELEARNING MODULE NUMBER)	assignments
WEEK 1			
NO LAB MEETING **(COMPLETE THE LAB SAFETY MODULE)** Read ECE 2100 Laboratory: Safety and Rules ECE 2100 Laboratory: Notebook Requirements View lecture #6 on electrical laboratory safety on ELearning (in *Fundamental Concepts* module) Complete and submit the SAFETY QUIZ DUE BY 9/9 5PM to lab instructor ELearning Dropbox.			
1	8/31	**Course Overview** 1. Course welcome, overview, and syllabus review 2. How to succeed in this course	Purchase McGraw-Hill access Install LTspice®

		3. What engineers do (and engineering design vs. engineering analysis)	Acquire safety glasses and multimeter read syllabus read CH 1: *Basic Concepts* HW #1: Connect Orientation DUE 9/12
2	9/2	What engineers do (and engineering design vs. engineering analysis) 4. "Greatest Engineering Achievements of the 20th Century" 5. Overview of electrical engineering IEEE Societies **Fundamental Concepts** 6. Electrical laboratory safety (and lab notebook requirements) 7. What is a circuit?	HW #2: (CH 1 and 2) DUE 9/21
WEEK 2			
NO LAB MEETING **(COMPLETE LAB 1 INDIVIDUALLY AT HOME)** You can seek help during any lab instructor lab meeting times or office hours. LAB 1: Passive Sign Convention and LTspice® Introduction (SIMULATION ONLY) REPORT DUE BY 9/16 5PM to lab instructor ELearning Dropbox Each student submits a report (no lab teams). Submit your lab notebook pages as your report (one per person). No other documentation is required.			
	9/5	**NO CLASS: LABOR DAY RECESS**	
3	9/7	What is a circuit? 8. *Charge and Current* (1.3) 9. *Voltage (1.4)*	
4	9/9	*Voltage (1.4)* 10. *Ohm's Law* (2.2), power, conservation of energy (1.5), and the passive sign convention 11. *Circuit Elements* (1.6)	LAB SAFETY QUIZ DUE Read CH 2: *Basic Laws*
WEEK 3			
LAB 2: Basic Circuit Measurements and Ohm's Law REPORT DUE BY 9/23 5PM to lab instructor ELearning Dropbox			
5	9/12	*Circuit Elements* (1.6) 12. Resistance and Conductance 13. *Problem Solving* (1.8) 14. Engineering analysis vs. design [online only, discussed in lecture topic #3] 15. network topology (2.3)	HW #1 DUE HW #3: (CH 2) DUE 9/26
6	9/14	16. *Kirchhoff's Laws* (2.4)(KCL) 17. *Kirchhoff's Laws* (2.4)(KVL)	
7	9/16	18. Series resistors/voltage divider (2.5) 19. Wheatstone Bridge (4.10.2) 20. Parallel resistors/current divider (2.6) 21. Equivalent resistance (2.6)	LAB 1 REPORT DUE Read CH 3: *Methods of Analysis*
WEEK 4			
LAB 3: Series and Parallel Circuits REPORT DUE BY 9/30 5PM to lab instructor ELearning Dropbox			
8	9/19	22. *Wye-Delta Transformations* (2.7) 23. *Design of DC Meters* (2.8.2)	HW #4: (CH 3) DUE 10/5
9	9/21	*Design of DC Meters* (2.8.2)	HW #2 DUE

		24. Meter sensitivity ***Nodal and Mesh Analysis*** 25. *Nodal Analysis* (3.2)(also 3.3)	
10	9/23	*Nodal Analysis* (3.2)(also 3.3)	LAB 2 REPORT DUE Read CH 4: *Circuit Theorems*
WEEK 5			
LAB 4: Basic DC Meter Design REPORT DUE BY 10/7 5PM to lab instructor ELearning Dropbox. Remember to include the Ammeter/Voltmeter Performance Evaluation Worksheet as the last page of your report. **EACH student must also submit a Laboratory Team Self-Assessment FORM to receive credit for this report.** DO NOT include this form as part of the report in order to maintain confidentiality. Rather, submit in the SEPERATE Team Assessment Dropbox.			
11	9/26	26. *Mesh Analysis* (3.4)(also 3.5) 27. *Nodal and Mesh Analyses by Inspection* (3.6) 28. Comparing nodal and mesh analysis (3.7)	HW #3 DUE HW #5: (CH 4) DUE 10/10
12	9/28	***Circuit Theorems*** (CH 4) 29. *Source Transformation* (4.4)	
13	9/30	30. Linear systems (4.2) 31. *Superposition* (4.3)	LAB 3 REPORT DUE Read CH 5: *Operational Amplifiers*
WEEK 6			
LAB 5: Nodal and Mesh Analysis: Comparison of Analysis, Simulated, and Experimental Results REPORT DUE BY 10/14 5PM to lab instructor ELearning Dropbox.			
14	10/3	*Superposition* (4.3) 32. Thevenin equivalent circuits (4.5)	
15	10/5	Thevenin equivalent circuits (4.5) 33. Negative resistance 34. Norton equivalent circuits (4.6) 35. *Maximum Power Transfer* (4.8) ***Operational Amplifiers*** (CH 5) 36. *Ideal Op Amp* (5.3) 37. Internal circuitry of LM741 op-amp LM741 Operational Amplifier Datasheet Chip Hall of Fame: Fairchild Semiconductor μA741 Op-Amp 38. Inverting and non-inverting configurations (5.4, 5.5) 39. Non-inverting amplifier as negative feedback system 40. Operational amplifier applications: buffer amplifier	HW #4 DUE HW #6: (CH 5) DUE 10/28
16	10/7	41. Operational amplifier applications: voltmeter w/ meter movement 42. Operational amplifier applications: I-V converter 43. Operational amplifier applications: *Summing Amplifier* (5.6) 44. Operational amplifier applications: *Difference Amplifier* and Common Mode Rejection Ratio (CMRR)	LAB 4 REPORT DUE
WEEK 7			
LAB 6: Superposition and Thevenin's Theorem REPORT DUE BY 10/24 5PM to lab instructor ELearning Dropbox			
17	10/10	Operational Amplifier Recap 45. Operational amplifier applications (a) Instrumentation amplifier (Example 5.8) Linear Technology LT1167 Precision Instrumentation Amplifier datasheet NovaSensor NPC-1220 Series Medium Pressure Sensors	HW #5 DUE

18	10/12	Operational amplifier applications J. Stahl, Dual Channel Low Noise Amplifier for Experiments In Neurophysiology, Master of Science in Electrical Engineering Thesis, 2009. (b) V-I converter using diff amp: Essenburg, Lucas M., "Intracellular Electrometer" (2019). Master's Theses: https://scholarworks.wmich.edu/masters_theses/5099 Dr. John Jellies Laboratory **Capacitors and Inductors** (CH 6) 46. *Sinusoids* (9.2) 47. Capacitance (6.2, 6.3): Fundamentals/Charging/Lemon Battery Application/Terminal Characteristics/Power/Energy/ Switched RC Circuit/Sinusoidal Excitation/Equivalent Capacitance	Read CH 6: *Capacitors and Inductors* HW #7 (CH 6) DUE 10/31
19	10/14	**QUIZ** **EXAM 1 REVIEW** Covers CHs 1-4 *NOTE: Sample exams are for practice only; your exam might not look anything like these!* Exam #1 Spring 2015 Exam #1 Summer I 2015 Exam #1 Fall 2015 Exam #1 Spring 2016 Exam #1 Fall 2016 Exam #1 Spring 2017 Exam #1 Summer I 2017 Exam #1 Fall 2017 Exam #1 Spring 2018 Exam #1 Fall 2018 Exam #1 Spring 2019 Exam #1 Summer I 2019 Exam #1 Fall 2019 Exam #1 Spring 2020 Exam #1 Fall 2021 Exam #1 Spring 2022 Exam #1 Summer I 2022	LAB REPORT 5 DUE
WEEK 8			
NO LAB			
20	10/17	**EXAM 1** (no calculators, bring WMU ID)	
	10/19	**NO CLASS: Fall Break**	
	10/21	**NO CLASS: Fall Break**	
WEEK 9			
LAB 7: Basic Waveforms and Oscilloscope Operation REPORT DUE BY 11/4 5PM to lab instructor ELearning Dropbox			
21	10/24	Review graded Exam #1	LAB REPORT 6 DUE Read 13.2 *Mutual Inductance*, 13.5 *Ideal Transformers*, and 13.9.3 *Power Distribution*

22	10/26	Capacitance (6.2, 6.3): Switched RC Circuit/Sinusoidal Excitation/Equivalent Capacitance 48. Electronic integrators/differentiators (6.6.1, 6.6.2) *Analog Computer* (6.6.3, Example 6.15) 49. Supercapacitors https://www.technologyreview.com/2013/11/12/175448/graphene-supercapacitors-ready-for-electric-vehicle-energy-storage-say-korean-engineers/ D. Salerno, "Low Profile Supercapacitor Power Backup with Input Current Limiting," *LT Journal of Analog Innovation*, Nov. 2015: http://cds.linear.com/docs/en/lt-journal/LTJournal-V25N3-03-df-LTC3128-DaveSalerno.pdf 50. Inductance (6.4, 6.5): Fundamentals/Terminal Characteristics/Power/Energy/Switched Parallel RL Circuit/	HW #8: (CH 9) DUE 11/9 Read CH 9: *Sinusoids and Phasors* Read Appendix B: *Complex Numbers*
23	10/28	Inductance (6.4, 6.5): Equivalent Inductance/Sinusoidal Excitation/Example Inductors Triad Dual-Function Chokes Coilcraft BCL/BCR Series Conical Inductors **VIEW LECTURES 51-52 ON eLEARNING:** 51. *Ideal transformers* (13.5)/applications (13.9.3 *Power Distribution*, Parkview Campus transformer failure) *Transformers, The Unsung Technology* United States Electricity Industry Primer (see page 22 for figure used in class) Mill Creek Generating Station (1465MW Generation Capacity, Dr. Miller worked there as an intern) Technical details available here. Parkview Campus Transformer Failure *Details courtesy Dan Brimmer/Lucas Essenburg* U.S. electricity generation by energy source (updated to 2019) 52. *Mutual* Inductance *(13.2)* ***Sinusoids and Phasors*** (CH 9) 53. Importance of sinusoids in engineering Weisstein, Eric W. "Fourier Series--Square Wave." From *MathWorld*--A Wolfram Web Resource. http://mathworld.wolfram.com/FourierSeriesSquareWave.html 54. Introduction to phasors (9.3) Brief Review of Complex Numbers	HW #6 DUE
WEEK 10			
LAB 8: Operational Amplifier Circuits NationalSemiconductorModels.lib (This is a text file with a circuit model of the LM741 from National Semiconductor. Right click on the link and save the file OR open the file in your browser and save the file in the same directory as your LTspice® schematic. Put the SPICE directive ".include NationalSemiconductorModels.lib" in your schematic). REPORT DUE BY 11/11 5PM to lab instructor ELearning Dropbox			
24	10/31	Introduction to phasors (9.3)	HW #7 DUE

		55. Passive circuit elements in the phasor domain (9.4) 56. *Impedance and Admittance* (9.5) 57. Analysis of circuits in the sinusoidal steady state using phasors (9.6): RL example; **LAST DAY TO WITHDRAW**	
25	11/2	DISCUSS LAB 9 SETUP; Analysis of circuits in the sinusoidal steady state using phasors (9.6): RLC example, KVL and KCL in phasor domain 58. Equivalent impedance (9.7) 59. Resonance in parallel RLC circuit	Read CH 10: *Sinusoidal Steady-State Analysis*
26	11/4	60. Using resonant LC circuit to tune a radio 61. RC low and high-pass filters/Application to speaker crossover network	LAB REPORT 7 DUE HW #9: (CH 10, 11) DUE 11/21 Read CH 11: *AC Power Analysis* Read 13.9.2 *Transformer as a Matching Device*
WEEK 11			
LAB 9: Steady-State AC Behavior of Passive Circuit Elements REPORT DUE 11/18 5PM to lab instructor ELearning Dropbox.			
27	11/7	**Circuit Analysis in the Phasor Domain** 62. Circuit analysis in the phasor domain (10)	
28	11/9	Circuit analysis in the phasor domain (10) (Additional worked examples are available in online ELearning videos) 63. *Capacitance Multiplier* (10.9.1)	HW #8 DUE
29	11/11	**AC Power Analysis** 64. Root Mean Square Value (11.4) 65. *Instantaneous and Average Power* (11.2) 66. *Complex Power* (11.6)	LAB REPORT 8 DUE
WEEK 12			
LAB 10: Frequency and Intuitive Step Response of RC Filters REPORT DUE 11/28 5PM to lab instructor ELearning Dropbox. Remember to include the RC Low Pass Filter Design Worksheet as the last page of your report. **EACH student must also submit a Laboratory Team Self-Assessment FORM to receive credit for this report.** DO NOT include this form as part of the report in order to maintain confidentiality. Rather, submit in the SEPERATE Team Assessment Dropbox.			
30	11/14	67. *Power Factor Correction* (11.8) 68. Q in the time domain: theory and simulation	
31	11/16	69. *Maximum Average Power Transfer* (11.3) 70. Impedance matching w/ transformer (13.9.2) 71. Resonance w/ radio tuning (online ELearning video lecture includes show-and-tell)	
32	11/18	**QUIZ** **EXAM 2 REVIEW** Covers all material except CH 7 and 8 *NOTE: Sample exams are for practice only; your exam might not look anything like these!* (no calculators, bring WMU ID) Exam #2 Spring 2015 Exam #2 Summer I 2015 Exam #2 Fall 2015 Exam #2 Spring 2016	LAB REPORT 9 DUE Read CH 7: *First-Order Circuits*

		Exam #2 Fall 2016 Exam #2 Spring 2017 Exam #2 Summer I 2017 Exam #2 Fall 2017 Exam #2 Spring 2018 Exam #2 Fall 2018 Exam #2 Spring 2019 Exam #2 Summer I 2019 Exam #2 Fall 2019 Exam #2 Fall 2021 Exam #2 Spring 2022 Exam #2 Summer I 2022	
WEEK 13			
LAB 11: AC Power Factor and Power Factor Correction REPORT DUE 12/2 5PM to lab instructor ELearning Dropbox.			
33	11/21	***First-Order Circuits*** (CH 7) 72. Steady-state vs. transient analysis 73. Natural response (RC)(7.2) 74. Natural response (RL) (7.3)	HW #9 DUE
34	11/23	**EXAM 2** (no calculators, bring WMU ID)	
	11/25	**NO CLASS: Thanksgiving**	
WEEK 14			
LAB 12: Step Response of an RC Circuit LAB 13: Step Response of an RLC Circuit ABBREVIATED LAB REPORT DUE 12/9 5PM to lab instructor ELearning Dropbox. Submit one lab report for Labs 12 and 13. The lab report consists ONLY of a cover page; Table 1 from Lab 12; and the pre-lab and lab notebook pages for Lab 13.			
35	11/28	75. *Singularity Functions* (7.4) 76. Step response (RC)(7.5) 77. Step response (RL)(7.6)	LAB REPORT 10 DUE HW #10 (CH 7,8) DUE 12/9
36	11/30	78. General solution for effects of initial condition and switched DC sources (pg. 298) ***Second-Order Circuits*** (CH 8) 79. Series RLC natural response (8.3)	Read CH 8: *Second-Order Circuits*
37	12/2	80. Series RLC step response (8.5), including unstable response for negative resistance 81. Parallel RLC step response (8.6) 82. *General Second Order Circuits* (8.7)	LAB REPORT 11 DUE Mathematica® notebook based on Ex. 8.7 of the text is available here
WEEK 15 **MAKE-UP LABS** (you must have permission from the course instructor to perform a make-up lab)			
38	12/5	***Advanced Topics*** 83. Nonlinear chaotic Chua's Circuit	Advanced Topics (optional): Skim Kennedy papers [11][12] in references. [13] and [14] are excellent dynamical systems texts. Simulate Chua's Circuit. The LTspice® file is available via a link in this syllabus. View Chaotic Waterwheel video
39	12/7	Final Exam Review	

		NOTE: Sample exams are for practice only; your exam might not look anything like these! Final Exam Spring 2015 Final Exam Summer I 2015 Final Exam Fall 2015 Final Exam Spring 2016 Final Exam Fall 2016 Final Exam Spring 2017 Final Exam Summer I 2017 Final Exam Fall 2017 Final Exam Spring 2018 Final Exam Fall 2018 Final Exam Spring 2019 Final Exam Summer I 2019 Final Exam Fall 2019 Final Exam Fall 2021 Final Exam Spring 2022 Final Exam Summer I 2022	
40	12/9	Review graded Exam #2 Course wrap-up Accelerated master's programs Encourage instructor evaluation participation	LAB REPORT 12/13 DUE HW #10 DUE
WEEK 16			
41	TUE 12/13	**FINAL EXAM** (cumulative) **10:15AM-12:15PM** (no calculators, bring WMU ID) Verify date/time on your own. Cumulative	

