EE 2415
Circuit Analysis I

Summer 2013
Dr. Howard T. Russell, Jr.
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Catalog Course Description:
EE 2415 CIRCUIT ANALYSIS I (3-3) Basic circuit concepts of resistor, inductor, and capacitor (RLC) components. Kirchhoff's laws, resistive network analysis, power calculations, loop and node equations, topology, basic network theorems. Dependent sources and operational amplifiers. Computer-assisted solution of circuit problems. Elementary transient time-domain analysis. Introduction to frequency domain analysis and Bode plots. Steady state A-C phasor analysis, including element laws and phasor diagrams. Problems and experimental demonstrations will be covered during recitation and laboratory sessions. Prerequisite: Grade C or better in EE 1205, MATH 2425. Co-requisite: MATH 3319, PHYS 1444.

Topics:
EE 2415 is the first complete course on electric circuit theory and analysis. The course begins with topics on basic electrical engineering quantities and variables and quickly progresses into a review of the fundamental network laws (Ohm's and Kirchhoff's). Following this review is an introduction into voltage and current sources. Resistors and basic resistor networks and operations are covered next. A set of network theorems are developed from the application of the fundamental laws on resistive networks. Matrix methods are applied to the generation and solution of a system of linear network equations (MAME and NAME). The second part of the course begins with the introduction into energy storage elements – the capacitor and the inductor. The behavioral characteristics of the elements in the time-domain are explored with the application of differential equations on the analysis equations. Complete time-domain solutions of first and second order network are developed. The course ends with the application of steady-state concepts on RLC networks, and the development and application of phasors.

Prerequisite:
EE 1205, MATH 2425, co-requisite: MATH 3319, PHYS 1444.

Textbook:
R.C. Dorf and J.A. Svoboda, *Introduction to Electric Circuits*, *8th Edition*, John Wiley & Sons, Inc., 2010, ISBN 978-0-470-52157-1.

Tools:
1. Scientific calculator. Calculators as components in communication devices are not allowed on exams.
2. Breadboard (mandatory).
3. Toolbox (mandatory) – containing an assortment of electronics tools consisting of needle nose pliers, diagonal cutters, tweezers, precision knife set, pocket screwdrivers.
4. A good web browser.

Times and Location:
Lecture – Tuesday and Thursday, 10:30 am to 12:20 pm, Nedderman Hall room 106.
Recitation/Laboratory – Wednesday, 1:00 pm to 3:50 pm, Nedderman Hall, room 106.

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GTA:
Lecture and lab: TBD

Lecture Schedule				
Week/Date		**Tuesday**	**Thursday**	**Reading Assignment**
1	6-4/6	Electrical quantities, system of units, charge and energy, current and voltage, power and energy.	Network models, circuit elements, resistors, independent voltage and current sources, Ohm's law, meters, dependent voltage and current sources.	Chapter 1 – 1.2 to 1.8
2	6-11/13	Transducers, switches, Kirchhoff's laws, series and parallel resistors, divider circuits, source dominance, PSPICE.	Mesh analysis matrix equation (MAME).	Chapter 2 – 2.1 to 2.9 Chapter 3 – 3.1 to 3.6 Handouts
3	6-18/20	Node analysis matrix equation (NAME).	Source transformations, superposition, Thevenin's and Norton's theorems, maximum power transfer.	Chapter 4 – 4.1 to 4.8 Handouts
4	6-25/27	The operational amplifier (op-amp), ideal and non-ideal op-amp, node analysis.	**Mid-term Exam 1**	Chapter 5 – 5.1 to 5.6 Chapter 6 – 6.1 to 6.7
5	7-2/3*	Energy storage elements, capacitors, energy stored in capacitors, series and parallel capacitors.	Inductors, energy stored in inductors, series and parallel inductors.	Chapter 7 – 7.1 to 7.4
6	7-9/11	Initial conditions in switched circuits, op-amps and RC circuits.	First-order RC and RL circuits, constant input, sequential switching, non-constant input, differential operators.	Chapter 7 – 7.5 to 7.9
7	7-16/18	Circuits with two energy storage elements, 2nd order differential equations.	Natural, forced, and complete response of a critically-damped parallel RLC circuit.	Chapter 8 – 8.1 to 8.8 Chapter 9 – 9.1 to 9.5
8	7-23/25	Concept of state, state variable circuit analysis, sinusoidal sources.	**Mid-term Exam 2**	Chapter 9 – 9.6 to 9.9 Chapter 10 – 10.1 to 10.3
9	7-30/8-1	Steady-state response of an RL circuit to a sinusoidal excitation, complex exponential forcing function.	Phasors, phasor relationships for RLC elements, impedance and admittance, Kirchhoff's laws using phasors.	Chapter 10 – 10.6 to 10.5
10	8-6/8	Mesh and node circuit analysis using phasors, superposition, Thevenin's and Norton's equivalents, source transformations.	Electric power, maximum power transfer, instantaneous, average, and complex power, power factor.	Chapter 10 – 10.4 to 10.13 Chapter 11 – 11.1 to 11.8
11	8-13	**Final Exam**		

***** Thursday lecture given during the Wednesday recitation session.

Lecture Topic Details:

1. Review of algebra and linear algebra concepts
2. Fundamentals
    a. Quantities and variables
        1. Electron energy and charge
        2. Voltage and current
        3. Energy and power
        4. Polarities and units
    b. Laws
        1. Voltage-current relationship (Ohm's law)
        2. Conservation of charge transfer (Kirchhoff's current law KCL)
        3. Continuity of voltage (Kirchhoff's voltage law KVL)
3. Voltage and current sources
    a. Independent sources
        1. Voltage sources
            i. Types and symbols
            ii. IV characteristics
            iii. Batteries
        2. Current sources
            i. Types and symbols
            ii. IV characteristics
    b. Dependent (controlled) sources
        1. Voltage sources
            i. VCVS
            ii. CCVS
        2. Current sources
            i. VCCS
            ii. CCCS
4. Resistors and simple resistor networks
    a. Resistance and conductance; construction, symbol, units
    b. Series connection
        1. Voltage divider
    c. Parallel connection
        1. Current divider
5. Network theorems I
    a. Source dominance
    b. Source combinations
    c. Source shifting
        1. e-shift operation
        2. i-shift operation
    d. Source transformations
        1. Voltage to current
        2. Current to voltage
6 Network theorems II
    a. Superposition
    b. Thevenin's theorem
    c. Norton's theorem
7. Application of network theorems to simple networks
    a. Reduction operations
    b. Elimination operation
    c. Equivalence operations
8. Vectors and matrices
    a. Definitions
    b. Mathematical operations
    c. Special matrices
    d. Matrix inverse

e. Rank and equivalence
9. System of linear equations
   a. Dependence and independence
   b. Solutions of systems of simultaneous linear equations
10. Obtaining the system of network mesh-analysis equations
   a. Direct application of KVL, KCL, and Ohm's law
   b. Expressing the equations in vector-matrix format
11. Obtaining the system of network node-analysis equations
   a. Direct application of KVL, KCL, and Ohm's law
   b. Expressing the equations in vector-matrix format
12. Algorithms for generating matrix analysis equations
   a. Mesh-analysis matrix equation (MAME)
   b. Node-analysis matrix equation (NAME)
13. Energy storage components
   a. The capacitor
      1. Construction and symbol
      2. Charge-voltage (CV) relationship
      3. Current-voltage (IV) relationship
      4. Definition of capacitance
      5. Energy storage capacity
   b. The inductor
      1. Construction and symbol
      2. Flux linkage-current (λI) relationship
      3. Current-voltage (IV) relationship
      4. Definition of inductance
      5. Energy storage capacity

References:

1. F.T. Ulaby and M.M. Maharbiz, *Circuits*, National Technology and Science Press, 2009, ISBN 978-1-934891-00-1
2. Thomas L. Floyd, *Electric Circuits Fundamentals, 7th Edition*, Pearson Prentice Hall, Upper Saddle River, NJ, 2007, ISBN 0-13-219710-3
3. Robert T. Paynter and B.J. Toby Boydell, *Electronics Technology Fundamentals: Electron Flow Version*, Pearson Prentice Hall, Upper Saddle River, NJ, 2009, ISBN 0-13-501345-3
4. Allan R. Hambley, *Electrical Engineering: Principles and Applications, 3rd Edition*, Pearson Prentice Hall, Upper Saddle River, NJ, 2005, ISBN 0-13-147046-9
5. J. David Irwin and R. Mark Nelms, *Basic Engineering Circuit Analysis, 8th Edition*, John Wiley & Sons, Inc., 2005, ISBN 0-471-48728-7

Student Learning Outcomes:

EE 2415
Course Learning Objectives
and Assessment Approach

Number	Course Learning Objective (CLO)	ABET Outcome	Assessment Approach
1	An understanding of dependent sources and their application in generating device models.	a, e	exam problems
2	An ability to mathematically formulate multiple mesh and node analysis matrix equations for linear networks with and without dependent sources.	a, e	exam problems
3	An understanding of network theorems such as superposition, Thevenin's and Norton's theorem, and maximum power transfer.	a, e	exam problems

4	An understanding of energy storage elements such as capacitors and inductors, voltage and current relationships, and energy storage.	a, e	exam problems
5	An understanding of first-order RC and RL circuits, constant input, sequential switching, non-constant input, differential operators.	a, c, e	exam problems
6	An understanding of circuits with two energy storage elements, 2nd order differential equations, natural, forced, and complete response of a critically-damped parallel RLC circuit.	a, e	exam problems
7	An understanding of steady-state response of an RLC circuit to a sinusoidal excitation, complex exponential forcing function.	a, e	exam problems
8	An understanding of phasors, phasor relationships for RLC elements, impedance and admittance, Kirchhoff's laws using phasors.	a, e	exam problems
9	The application of computer tools and software in the solution of circuit design problems.	a, k	lab experiments
10	An ability to use conventional electrical engineering instruments and equipment.	a, e, k	lab experiments
11	A working understanding of important analytical principles.	a, b, c	lab experiments
12	An ability to work as a member of a team.	d	lab experiments
13	An ability to understand and resolve professional ethical issues.	f	lab experiments

Outcomes a-k
(a-k as listed by ABET)

a. an ability to apply knowledge of mathematics, science, and engineering;
b. an ability to design and construct experiments, as well as to analyze and interpret data;
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;
d. an ability to function on multidisciplinary teams;
e. an ability to identify, formulate, and solve engineering problems;
f. an understanding of professional and ethical responsibility;
g. an ability to communicate effectively;
h. the broad education necessary to understand the impact of engineering solutions in a global and societal context;
i. a recognition of the need for, and an ability to engage in lifelong learning;
j. a knowledge of contemporary issues;
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

General Class Information:

1. There are 21 class meetings scheduled for the 11 weeks of the Summer 2013 Semester. Eighteen of these meetings are devoted to class lectures and three devoted to examinations – two mid-terms and one final.
2. Your 100% attendance in lectures and labs is mandatory and required. This requirement will not be waived for any reason.
3. Mid-term examinations will be given on the 4^{th} and 8^{th} weeks, and will be two hour written exercises.
4. The final examination will be given on the 11^{th} week and will be a comprehensive written examination. **NOTICE**: The UTA registrar has demanded a firm, unforgivable final date (one calendar day after the last final examination date) for the submission of course grades from all instructors. Because of this rigid schedule, the date and time scheduled for the final examination (**Tuesday August 13, 2013, 10:30 am to 12:30 pm)** is fixed and will not be changed for any reason. Therefore, all students, without exception, **must** take the final examination at this time.
5. You are requested to turn off any and all communication devices while in the Lecture and the Recitation/Lab Sections. Communication devices of any type are not allowed to be used on any and all exams. No exceptions. Calculators without communication capability are permitted.
6. All examinations will be pencil, paper, and calculator exercises. All students will take these exams at the scheduled times in the classroom.
7. There will be **absolutely** no late or make-up mid-term or final examination given unless a written request has been submitted to and approved by the instructor at least two weeks prior to the examination date. As a rule, make-up examinations are several orders of magnitude more difficult than examinations given on the scheduled dates. Please be advised that illness or any other absence on the examination date does not constitute a valid reason for a make-up examination.
8. There will be five to six homework assignments, usually given on one or two-week intervals. Each assignment requires about five to ten hours for completion. These assignments will be graded and will be included as part of your total course grade. Past experience has shown that students who spend the necessary time to work these assignments usually do quite well on the examinations. Solutions to homework problems will be e-mailed to all students by the end of the day the assignment is due. Homework turned in after the solutions have been sent out will not be counted and will receive a grade of zero.
9. The total grade for this course is based upon the homework (HW), recitation/lab (LA), two mid-term exams (MTE1 and MTE2), and the final exam (FE) grades. The total grade is computed from

   $$\text{Total grade} = 0.1*HW + 0.1*LA + 0.25*(MTE1 + MTE2) + 0.3*FE$$

   The letter grade is based on the range of the total grade shown below.

Percentage for Grades	
Total grade range	Letter grade
88% - 100%	A
75% - 87%	B
63% - 74%	C
50% - 62%	D
0% - 49%	F

10. In order to adhere to current privacy law requirements, class grades will not be posted. If you wish to receive your final examination paper and/or your class grade prior to their mailing by the registrar, please give me a large self-addressed and adequately stamped envelope prior to the final examination date so that I may mail your papers and grade to you.
11. Office hours are posted outside my office (NH526). If you have any questions and/or adverse difficulty with the lectures or class material, I strongly suggest that you call or e-mail me (during regular working hours, of course). If necessary, a scheduled office visit can be arranged.
12. Additional important dates:
    Census date – **Thursday, June 20, 2013**.
    Last day to drop classes – **Thursday, July 18, 2013**.
    Last day of classes – **Thursday, August 8, 2013**.

Drop Policy:
Please refer to the University policy for dropping courses.

Americans With Disabilities Act:
The University of Texas at Arlington is on record as being committed to both the spirit and letter of federal equal opportunity legislation; reference Public Law 92-112 - The Rehabilitation Act of 1973 as amended. With the passage of federal legislation entitled *Americans with Disabilities Act (ADA)*, pursuant to section 504 of the Rehabilitation Act, there is renewed focus on providing this population with the same opportunities enjoyed by all citizens. As a faculty member, I am required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Student responsibility primarily rests with informing faculty of their need for accommodation and in providing authorized documentation through designated administrative channels. Information regarding specific diagnostic criteria and policies for obtaining academic accommodations can be found at www.uta.edu/disability. Also, you may visit the Office for Students with Disabilities in room 102 of University Hall or call them at (817) 272-3364.

Student Support Services Available:
The University of Texas at Arlington supports a variety of student success programs to help you connect with the University and achieve academic success. These programs include learning assistance, developmental education, advising and mentoring, admission and transition, and federally funded programs. Students requiring assistance academically, personally, or socially should contact the Office of Student Success Programs at 817-272-6107 for more information and appropriate referrals.

Final Review Week:
A period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week unless specified in the class syllabi. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. Classes are held as scheduled during this week and lectures and presentations may be given.

E-Culture Policy:
The University of Texas at Arlington has adopted the University email address as an official means of communication with students. Through the use of email, UT-Arlington is able to provide students with relevant and timely information, designed to facilitate student success. In particular, important information concerning registration, financial aid, payment of bills, and graduation may be sent to students through email. All students are assigned an email account and information about activating and using it is available at www.uta.edu/email. New students (first semester at UTA) are able to activate their email account 24 hours after registering for courses. There is no additional charge to students for using this account, and it remains active as long as a student is enrolled at UT-Arlington. Students are responsible for checking their email regularly.

Ethics:
Student Responsibility
Undergraduate and graduate students assume full responsibility for knowledge of all University rules, regulations and deadlines published in the Undergraduate and Graduate Catalogs and of all departmental and program requirements concerning their degree programs.

Academic Dishonesty
All students are expected to pursue their academic careers with honesty and integrity. Academic dishonesty includes, but is not limited to, cheating on a test or other coursework, plagiarism (offering the work of another as one's own) and unauthorized collaboration with another person. Students found responsible for dishonesty in their academic pursuits are subject to penalties that may range from disciplinary probation, suspension or expulsion from the University. In accordance with the Rules and Regulations of the Board of Regents of The University of Texas System (Part One, Chapter VI), institutional procedures regarding allegations of academic dishonesty are outlined in Part Two, Chapter 2, of the U.T. Arlington Handbook of Operating Procedures. This information may be obtained by accessing the Dean of

Students' Web site at www.uta.edu/studentaffairs/dos or the Student Judicial Affairs' Web site at www.uta.edu/studentaffairs/judicial affairs. Copies of each regulation can be obtained in the Dean of Students' Office on the lower level of the University Center.

Definitions (UTA Handbook of Operating Procedures)

F. scholastic dishonesty, including, but not limited to, cheating on an examination or an assignment, plagiarism, and collusion;

1. *cheating on an examination or an assignment* includes:
   a. copying the work of another, engaging in written, oral or any other means of communication with another, or giving aid to or seeking aid from another when not permitted by the instructor;
   b. using material during an examination or when completing an assignment that is not authorized by the person giving the examination or making the work assignment;
   c. taking or attempting to take an examination for another, or allowing another to take or attempt to take an examination for a student;
   d. using, obtaining, or attempting to obtain by any means, the whole or any part of an un-administered examination or work assignment;
   e. any act designed to give unfair advantage to a student or the attempt to commit such an act;
2. *plagiarism* means the unacknowledged incorporation of the work of another in work that is offered for credit;
3. *collusion* means the unauthorized collaboration with another in preparing work that is offered for credit.

The following is an excerpt from the College of Engineering's statement on Ethics, Professionalism, and Conduct of Engineering Students. Read the statement carefully, sign it, and return it to your instructor. You may make a copy for your records. Additional copies of this statement can be obtained from your instructor or the Office of the Dean of Engineering.

STATEMENT ON ETHICS, PROFESSIONALISM, AND CONDUCT
FOR ENGINEERING STUDENTS
COLLEGE OF ENGINEERING
THE UNIVERSITY OF TEXAS AT ARLINGTON

The College cannot and will not tolerate any form of academic dishonesty by its students. This includes, but is not limited to cheating on examination, plagiarism, or collusion.

Cheating on an examination includes:

1. Copying from another's paper, any means of communication with another during examination, giving aid to or receiving aid from another during examination;
2. Using any material during examination that is unauthorized by the proctor;
3. Taking or attempting to take an examination for another student or allowing another student to take or attempt to take an examination for oneself.
4. Using, obtaining, or attempting to obtain by any means the whole or any part of an un-administered examination.

Plagiarism is the unacknowledged incorporation of another's work into work which the student offers for credit.
Collusion is the unauthorized collaboration of another in preparing work that a student offers for credit.

I have read and I understand the above statement.

In addition, I understand that, in order to ensure fairness to all students, exams will be proctored and possibly videotaped.

Course and section number: ____EE 2415-001/101_____

Date: _____

Student's signature: _____

Student's name, printed: _____

Student's ID number: _____

Student's e-mail address: _____
(please print clearly)