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ECE Guidelines
for
EE 2100 Circuits I, EE 2120 Circuits II, EE 2200 Introduction to Electronic Devices, and CpE 2210 Introduction to Computer Engineering and their associated Laboratories.

Missouri University of Science and Technology
Version 2020

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Introduction

The required sophomore-level courses and their associated Advancement Examinations in the EE and CpE curricula are:

- EE 2100 Circuits I and EEAE I
- EE 2120 Circuits II and EEAE II
- EE 2200 Introduction to Electronic Devices and EEAE III
- CpE 2210 Introduction to Computer Engineering and CpEAE

These courses lay the basis for the material presented in subsequent courses. As such they have common finals which serve as separate degree Advancement Examination requirements. Also, the common finals/Advancement Examinations provide measures for the department ABET accreditation process and serve as placement examinations for transfer students. The department chair appoints coordinators which are responsible for the content, format, and retake policy for these common finals/Advancement Examinations. The intent of the appointments is to maintain reasonable consistency as the department meets these functions from semester to semester.

The current coordinators are:

EE 2100, EE 2120, and EE 2200: Steve E. Watkins, Associate Chair for EE UG Studies
CpE 2210: R. Joe Stanley, Associate Chair for CpE UG Studies

They are responsible for this policy document, its implementation, and its revision.

2.0 Course Content

Excerpts from the course descriptions used in the 2014 ABET Report of the ECE Department are shown. The catalog description and prerequisites have not changed for the current Missouri S&T Catalog. Note that students should enroll in the associated laboratories EE 2101, EE 2201, and CpE 2211 as co-requisites for the classes.

2.1 EE 2100 Circuits I

Catalog Description:

[Lec. 3.0] Circuit elements, signals, Kirchhoff's laws, network transforms, mesh and node analysis, transient and complete response of RL, RC, and RLC circuits.
Prerequisites: Math 1215 Calculus II with a Grade of "C" or better.

Prerequisites by topic: Differential and integral calculus

Textbooks and other required material: CIRCUIT ANALYSIS CP 281000016098B. Chapters 1-5, 7-9. Publisher: Missouri S&T bookstore.

Course learning outcomes/expected performance criteria:

1. Understand the behavior of basic circuit elements and basic circuits
2. Learn to apply the fundamental network laws for circuit analysis
3. Learn to simplify linear circuits and to represent circuit signals
4. Introduce the analysis of transient and complete response in first-order and second-order circuits

Topics covered:

1. Units, Charge, Current, Voltage, Work, and Power
2. Kirchhoff's Current and Voltage Laws and Types of Sources
3. Resistance, Capacitance, and Inductance
4. Parallel and Series Circuits, Current Dividers, and Voltage Dividers
5. Review of Simultaneous Equations
6. Network Analysis by Node Voltages and Mesh Currents
7. Linearity, Superposition, Thevenin's Theorem, and Norton's Theorem
8. Signals, Average Values, and RMS Values
9. First-Order Circuits
10. Second-Order Circuits
11. Reviews, Examinations, and Final Examination

2.2 EE 2120 Circuits II

Catalog Description:

[Lec. 3.0] Analysis of steady-state AC circuits, phasor notation, polyphase circuits, complex frequency and frequency response, magnetically-coupled circuits.
Prerequisites: Both Math 2222 Calculus III and El Eng 2100 Circuits I with a grade of "C" or better; Passing grade on EE Advancement Exam I (EEAE-I).

Prerequisites by topic: Differential and integral calculus, basic circuit analysis and transient circuit analysis

Textbooks and other required material: CIRCUIT ANALYSIS CP 281000016098B. Chapters 10, 11, 12, 13, 17, and 18.

Course learning outcomes/expected performance criteria:

1. Learn fundamental concepts essential to success in subsequent courses as well as success in the professional practice of electrical engineering (e.g. Phasor, transfer functions, power, equivalent circuit representations).
2. Understand and develop proficiency in using computational aids (e.g. using matlab for frequency response plots, finding roots of polynomials using calculators, simultaneous solution of complex linear equations).

3. Introduce the idea of validity or invalidity of approximations in modeling electrical devices such as transformers.
4. Become aware of energy loss in electrical systems and devices.
5. Learn to appreciate the use of mathematical abstracts such as frequency domain to solve physical systems in time domain.

Topics covered:

1. Classical solution of circuit equations with differential equations
2. Complex numbers and phasor representation
3. AC Circuit Analysis
4. Single Phase Power
5. Frequency response
6. Mutual Inductance and Transformers
7. Three Phase Power
8. Reviews, Examinations, and Final Examination

2.3 EE 2200 Introduction to Electronic Devices

Catalog Description:

[Lec. 3.0] Materials and device structures for applications in analog and digital electronics. Topics include characteristics and basic circuits for diode, FET transistors, BJT transistors, and operational amplifiers. Prerequisites: Physics 2135, El Eng 2100 Circuits I, and El Eng 2101 Circuit Analysis Laboratory I with a Grade of "C" or better; Passing grade on EE Advancement Exam I (EEAE-I).

Prerequisites by topic: Physics basics in matter and energy and basic circuit analysis

Textbooks and other required material: Department Notes

Course learning outcomes/expected performance criteria:

1. Understand basic crystal physics including steady-state resistivity and carrier transport
2. Understand the behavior of basic characteristics of diodes, FETs, BJTs, and Ideal Op Amps
3. Learn to apply DC analyses to the devices listed above in digital and analog applications
4. Introduce fabrication techniques and junction structures in semiconductors

Topics covered:

1. Electrical safety, expectations for written laboratory notebooks and technical memorandum reports
2. Electronic materials and crystal physics
3. Carriers and doping in semiconductors
4. Drift and diffusion currents in semiconductors
5. Diode characteristics and diode circuits
6. Field effect transistor characteristics and biasing circuits
7. Bipolar junction transistor characteristics and biasing circuits
8. Analog and digital applications of transistors
9. Operational Amplifiers and Basic Circuit Configurations
10. Laser diodes and photodiodes
11. Device Fabrication
12. Reviews, Examinations, and Final Examination

2.4 CpE 2210 Introduction to Computer Engineering

Catalog Description:

[Lec. 3.0] Examines the core components from which digital systems are designed, constructed, and analyzed. Topics include binary numbers, truth tables, Boolean algebra, Karnaugh maps, combinational logic, digital components, CMOS, programmable logic devices, and sequential circuits.

Prerequisites by topic: None

Textbooks and other required material: IBSN: 9783319568379 (Seiffertt) and Lecture Notes

Course learning outcomes/expected performance criteria:

1. To describe the number systems used in digital systems and convert numbers from one number system to the other.
2. To perform binary arithmetic including unsigned addition, signed subtraction, multiplication and division.
3. To describe the basic and universal gate sets, their truth tables, properties, identities, and laws, and apply them to minimize digital functions.
4. To define the terminology used in specifying the functions in digital systems, minimize functions using K-maps, implement functions using PLA and PAL, and design the logic behind seven segment displays.
5. To list the problems and design difficulties associated with hardware manufacturing and calculate the propagation delay in digital circuits.
6. To describe different higher-order combinational circuits and apply them to implementing functions and simple digital systems.
7. To describe different flip-flops and memory elements designed from simple gates and use them to build registers, which are in turn used to build memories such as RAM and ROM.
8. To implement higher-order RAM circuits using smaller RAM modules.
9. To convert one type of flip-flop to another type of flip-flop.
10. To describe the structure of basic gates using CMOS technology.
11. To analyze a sequential network and design one from given specifications.
12. To implement simple projects in hardware and verify design specifications.

Topics covered:

1. Introduction to concepts in digital systems
2. Boolean algebra and logic gates
3. Combinational logic design
4. Digital hardware
5. CMOS logic circuits (selected topics)
6. Logic components
7. Memory elements and arrays
8. Sequential logic networks
9. Computer organization
10. First Concepts in VHDL (optional)

3.0 Prerequisites Structure for EE and CpE Coursework

3.1 Prerequisites for EE 2100, EE 2120, EE 2200, and CpE 2210

The prerequisites (including the minimum grades) for the following courses are required. If a student has a question regarding prerequisites for these courses, the EE or CpE Associate Chairs must approve any waivers. These waivers are rare and generally relate to how a students Mathematics courses transferred into the university. The department checks the prerequisites of enrolled student at the beginning of each semester and will inform students who need to drop. If these students do not drop the course, then the department will drop the student for lack of prerequisites.

> EE 2100: Math 1215 Calculus II with a Grade of "C" or better.
> EE 2120: Both Math 2222 Calculus III and El Eng 2100 Circuits I with a grade of "C" or better; Passing grade on EE Advancement Exam I (EEAE-I).
> EE 2200: Physics 2135, Math 1215 Calculus II, and El Eng 2100 Circuits I each with a grade of "C" or better; Passing grade on EE Advancement Exam I (EEAE-I).
> CpE 2210: No prerequisite.

Note that students should enroll in the associated laboratories EE 2101, EE 2201, and CpE 2211 as co-requisites for the classes. If students drop the lecture course after mid-semester, they are not required to drop the laboratory.

3.2 EE 2100, EE 2120, EE 2200, and CpE 2210 as Prerequisites

These sophomore-level courses and their Advancement Examinations are key prerequisites in the EE and CpE course sequence. (Other prerequisites may be needed for these upper-level courses as well, e.g. Phy 2135 for EE 3600.) If a student has a question regarding these courses as prerequisites, the EE or CpE Associate Chairs must approve any waivers. A partial list is shown below.

> EE 2120 and EE 2200: El Eng 2100 Circuits I with a grade of "C" or better; Passing grade on EE Advancement Exam I (EEAE-I). Other pre-requisites apply.
> EE 3100: El Eng 2120 Circuits II and EE 2200 Introduction to Electronic Devices with a grade of "C" or better; Passing grade on EE Advancement Exam II and III (EEAE-II & III).
> EE 3320, 3430, 3500, 3540, and 3600 (all required EE upper-level courses): El Eng 2120 Circuits II with a grade of "C" or better; Passing grade on EE Advancement Exam II (EEAE-II). Other pre-requisites may apply.
> EE Elective Courses: Both El Eng 2120 Circuits II with a grade of "C" or better. Passing grade on EE Advancement Exam II (EEAE-II). Other pre-requisites may apply.
> CpE 3150: CpE 2210 with a grade of "C" or better; Passing grade on CpE Advancement Exam (CpEAE).
> CpE 3110: CpE 2210 with a grade of "C" or better; Passing grade on CpE Advancement Exam (CpEAE).

4.0 Grading Policy

The finals for EE 2100, EE 2120, EE 2200, and CpE 2210 are common and serve as the

Advancement Examination associated with each course. Each semester the instructors for these courses prepare a final that is consistent with the content and format requirements in Section 6 and that is approved by the Advancement Examination coordinator. The instructors then grade the finals and set a passing score for that examination.

A student must earn a passing grade, i.e. a "C" or better, on the common final/Advancement Examination to satisfy the Advancement Examination requirement and to meet the prerequisite requirement for subsequent courses in ECE. A student must earn a passing grade, i.e. a "C" or better, on the common final/Advancement Examination to earn a "C" or better for the course grade. Any student that does not pass the Advancement Examination must be given a "D" or "F" for the course.

The grade for the Advancement Examination will not appear on a student's CAPS report or transcript. The grade on the exam will not directly impact the students GPA, but the grade will indirectly impact the GPA through the student's course grade.)

5.0 Electrical and Computer Engineering Advancement Examinations (EEAE and CpEAE)

5.1 Placement Examinations

The Advancement Examinations may be used as placement examinations for students transferring into the university at the discretion of the department.

1. The department chair or an associate chair schedules a time for the placement examination at the department convenience.
2. The placement examination (with solution and passing cutoff) is selected by the undergraduate secretary, department chair, or an associate chair from prior final examinations.
3. The placement examination is administered by a member of the department staff or faculty.
4. The placement examination is graded by the department chair or an associate chair and compared to the passing cutoff for that examination.
5. The scores on the placement exam are communicated to each student. If the score is above the passing cutoff or minimum passing score, students are informed that they have "passed" the advancement examination requirement and they may register for courses with the advancement examination as a prerequisite. Otherwise, the students are informed that they have not passed the advancement examination requirement and that they must take the associated Missouri S&T course. Placement examinations may not be retaken. The placement examinations are retained in the student files.

5.2 EEAE I: EE 2100 Circuits I

EE 2100 Format: Student work eight of ten problems for a two-hour examination
EE 2100 Content Emphasis:

General Concepts, Power Balance, Parallel and Series Equivalents, etc. (1 problem)
*Node and/or Mesh Analysis (2 problems)
*Thevenin and Norton Circuits, Maximum Power Transfer, and/or Source Transformations (2 problems)
Superposition (1 problem)

Signal Models, Power, Average and Effective (RMS) Values, etc. (1 problem)
Transient Analysis for Source-Free RC and/or Source-Free RL Circuits (1 problem)
Transient Analysis for Driven RC and/or Driven RL Circuits (1 problem)
Transient Analysis for Driven RLC Circuits (1 problem)

*Selected ABET Problem: Students will be given a multi-component circuit and will be asked to apply Node or Mesh analysis for the solution.
*Selected ABET Problem: Students will be given a multi-component circuit and will be asked to determine the Thevenin or Norton equivalent circuit.

5.3 EEAE II: EE 2120 Circuits II

EE 2120 Format: Student work eight of ten problems for a two-hour examination
EE 2120 Content Emphasis:

*Transfer Functions in jω and/or s-Domain Circuits (2 problems)
Node and/or Mesh Analysis (1 problem)
Thevenin and Norton Circuits, Maximum Power Transfer, and/or Source Transformations (1 problem)
Superposition (1 problem)
*Complex Power and/or Power Factor Correction (2 problems)
Mutual Inductance Circuits (1 problem)
Ideal Transformer Circuits (1 problem)
Three-Phase Circuits (1 problem)

*Selected ABET Problem: Students will be asked to determine a specified phasor voltage or current given a multi-component circuit or a transfer function H(s).
*Selected ABET Problem: Students will be asked to solve a complex power problem that requires them to apply the interrelationships among complex power, average power, and reactive power.

5.4 EEAE III: EE 2200 Introduction to Electronic Devices

EE 2200 Format: Student work eight of ten problems for a two-hour examination
EE 2200 Content Emphasis:

Semiconductor Crystal and Junction Physics (2 problems)
Diode Circuits (1 problem)
*Bipolar Junction Transistors (2 problems)
*Field Effect Transistors (2 problems)
*OpAmp Circuits (2 problems)
Optoelectronics (1 problem)

*Selected ABET Problem: Students will be given a transistor (BJT or FET) circuit and will be asked to determine the DC operating point.
*Selected ABET Problem: Students will be given an OpAmp circuit and will be asked to determine the output voltage or current as a function of input signal(s).

5.5 CpEAE: CpE 2210 Introduction to Computer Engineering

CpE 2210 Format: Student work all problems for a two-hour examination.
CpE 2210 Content Emphasis:

Number base conversions (decimal, binary, hexadecimal)
Complement-based number representation and arithmetic (addition, subtraction, Multiplication, division)
Hardware components (multiplexers, demultiplexers, adders, comparators, decoders, encoders, processor components and design)
Logic expression representation (basic logic gates, truth tables, complete logic sets, structured logic, different hardware components, drawing logic circuits)
Logic expression manipulation (complete logic sets, simplification, Karnaugh maps)
Memory elements (latches, flip-flops, timing diagrams, flip-flop transformation)
State machine design and implementation (Mealy machines, Moore machines) (state table, state transition diagram, circuit implementation)
CMOS circuit design (nFET and pFET transistor and switch models)

*Selected ABET Problem: Students will be asked to solve a word problem that requires them to formulate a solution and implement that solution using digital components.
*Selected ABET Problem: Students will be given a Boolean expression and will be asked to simplify the expression, put it into a canonical form, or to implement the expression using specified digital components.

6.0 Advancement Examination Retake Policy

6.1 Advancement Examination Retake Eligibility for EE 2100, EE 2120, and EE 2200

Students in EE 2100, EE 2120, and EE 2200 are allowed the option to re-take the final/advancement examination only if all of the following conditions apply.

- The student had a grade of "C" or better for an overall course grade including the final examination, typically 70% or greater.
- The student had a final score below the passing cutoff for the specific final as determined by the course instructors, typically the cutoff is 65-70%.
- The student had at least a 50% on the final.

If students meet these conditions, they are given the option of re-taking the final. The course instructor must give a non-passing course grade, i.e. "D" grade, by the semester grade reporting deadline.

6.2 Advancement Examination Retake Eligibility for CpE 2210

Students in CpE 2210 are allowed the option to re-take the final/advancement examination only if all of the following conditions apply.

- The student had a grade of "C" or better for an overall course grade including the final examination.
- The student had a final score below the passing cutoff for the specific final as determined by the course instructors.

- The student had at least a 50% on the final.

If students meet these conditions, they are given the option of re-taking the final. The course instructor must give a non-passing course grade, i.e. "D" grade, by the semester grade reporting deadline.

6.3 Procedure for Advancement Examination Retakes

Arrangements (place, date, and time) for the re-take examinations are set at the convenience of the department by the department chair or an associate chair. The re-take option is only available until the start of the next regular semester and is only available at the specified place, date, and time. (The re-take is typically scheduled immediately before the start of the next regular semester or within the first week of the next regular semester upon approval of the department chair or an associate chair.)

The procedure for re-take examinations is:

1. The instructor(s) inform the undergraduate secretary of the passing cutoff or minimum passing score on the final examination. All instructors must agree to the same cutoff score.
2. The instructor(s) inform the undergraduate secretary as to which students meet the stated conditions by the grade posting deadline.
3. The undergraduate secretary informs the eligible students through E-mail of the re-take option and of the available schedule(s) for the re-take examination as selected per the department convenience.
4. The re-take examination (with solution and passing cutoff) is selected by the undergraduate secretary, department chair, or an associate chair from prior final examinations.
5. The re-take examination is administered by a member of the department staff or faculty.
6. The re-take examination is graded by the department chair or an associate chair and compared to the passing cutoff for that examination.
7. The scores on the re-take exam are communicated to each student. If the score is above the passing cutoff or minimum passing score, students are informed that they have "passed" the advancement examination and the course. Otherwise, the students are informed that they have not passed the course and that they must adjust their semester schedule to retake the course. For the latter case, the "D" grade remains the permanent grade for the course.
8. For students that pass the re-take, the new final score is communicated to the course instructor who re-calculates the new overall course grade and submits a "Grade Change" form. The "Grade Change" form must be approved by the department chair or one of the associate chairs.

Students are not allowed a second re-take examination if they fail the first re-take examination. Students at transfer program institutions or transfer students taking an advancement examination to determine placement are not eligible for re-take examinations.

7.0 Syllabus Information

Instructors for EE 2100, EE 2120, EE 2200, and CpE 2210 should place the following information or its equivalent on their syllabus.

The prerequisites for [course number] are [prerequisite list per the catalog].

(For all except EE 2120) Student should enroll in [course number] and [laboratory number] simultaneously.

A student must earn a passing grade, i.e. a "C" or better, on the common final/Advancement Examination to satisfy the Advancement Examination requirement and to meet the prerequisite requirement for subsequent courses in ECE.

A student must earn a passing grade, i.e. a "C" or better, on the common final/Advancement Examination to earn a "C" or better for the course grade.

The retake policy does not need to be included in the syllabus.