ENGR M20: ELECTRICAL ENGINEERING FUNDAMENTALS

Originator
srelle

College
Moorpark College

Discipline (CB01A)
ENGR - Engineering

Course Number (CB01B)
M20

Course Title (CB02)
Electrical Engineering Fundamentals

Banner/Short Title
Elec Engr Fundamentals

Credit Type
Credit

Start Term
Spring 2020

Catalog Course Description
Introduces analysis of electrical circuits using analytical techniques based on the application of circuit laws and network theorems. Studies direct current (DC) and alternating current (AC) circuits containing resistors, capacitors, inductors, dependent sources, operational amplifiers, and switches. Investigates natural and forced responses of first and second order resistor-inductor-capacitor (RLC) circuits, use of phasors, AC power generation including power transfer and power factor correction calculations, and energy concepts.

Taxonomy of Programs (TOP) Code (CB03)
0901.00 - Engineering, General (requires Calculus) (Transfer)

Course Credit Status (CB04)
D (Credit - Degree Applicable)

Course Transfer Status (CB05) (select one only)
A (Transferable to both UC and CSU)

Course Basic Skills Status (CB08)
N - The Course is Not a Basic Skills Course

SAM Priority Code (CB09)
E - Non-Occupational

Course Cooperative Work Experience Education Status (CB10)
N - Is Not Part of a Cooperative Work Experience Education Program

Course Classification Status (CB11)
Y - Credit Course

Educational Assistance Class Instruction (Approved Special Class) (CB13)
N - The Course is Not an Approved Special Class

Course Prior to Transfer Level (CB21)
Y - Not Applicable

Course Noncredit Category (CB22)
Y - Credit Course

Funding Agency Category (CB23)
Y - Not Applicable (Funding Not Used)

Course Program Status (CB24)
1 - Program Applicable

General Education Status (CB25)
Y - Not Applicable

Support Course Status (CB26)
N - Course is not a support course

Field trips
Will not be required

Grading method
Letter Graded

Alternate grading methods
Student Option- Letter/Pass
Pass/No Pass Grading

Does this course require an instructional materials fee?
No

Repeatable for Credit
No

Is this course part of a family?
No

Units and Hours

Carnegie Unit Override
No

In-Class

Lecture
Minimum Contact/In-Class Lecture Hours
52.5
Maximum Contact/In-Class Lecture Hours
52.5

Activity

Laboratory

Total in-Class

Total in-Class
Total Minimum Contact/In-Class Hours
52.5
Total Maximum Contact/In-Class Hours
52.5

Outside-of-Class

Internship/Cooperative Work Experience

Paid

Unpaid

Total Outside-of-Class

Total Outside-of-Class
Minimum Outside-of-Class Hours
105
Maximum Outside-of-Class Hours
105

Total Student Learning

Total Student Learning
Total Minimum Student Learning Hours
157.5
Total Maximum Student Learning Hours
157.5

Minimum Units (CB07)
3
Maximum Units (CB06)
3

Prerequisites
PHYS M20B and MATH M35 or concurrent enrollment

Entrance Skills

Prerequisite Course Objectives
MATH M35-identify the type of a given differential equation and select and apply the appropriate analytical technique for finding the solution of first order and selected higher order ordinary differential equations.
MATH M35-evaluate first order differential equations including separable, homogeneous, exact, and linear.
MATH M35- show existence and uniqueness of solutions.
MATH M35-create and analyze mathematical models using first order differential equations to solve application problems such as circuits, mixture problems, population modeling, orthogonal trajectories, and slope fields.
MATH M35-solve second order and higher order linear differential equations.
MATH M35-create and analyze mathematical models using higher order differential equations to solve application problems, such as harmonic oscillator and circuits.
MATH M35-solve differential equations using variation of parameters.
MATH M35-evaluate Laplace Transforms.
MATH M35-solve linear systems of ordinary differential equations.
PHYS M20B-analyze simple static charge distributions and calculate the resulting electric field and electric potential.
PHYS M20B-analyze simple current distributions and calculate the resulting magnetic field.
PHYS M20B-predict the trajectory of charged particles in uniform electric and magnetic fields.
PHYS M20B-analyze DC and AC circuits in terms of current, potential difference, and power dissipation for each element.
PHYS M20B-recognize, recall, and apply the equations that describe physical phenomena involving thermodynamics and electromagnetism.

Requisite Justification

Requisite Type
Prerequisite

Requisite
PHYS M20B - Thermodynamics, Electricity, Magnetism

Requisite Description
Course not in a sequence

Level of Scrutiny/Justification
Required by 4 year institution

Requisite Type
Prerequisite

Requisite
MATH M35 - Applied Differential Equations

Requisite Description
Course not in a sequence

Level of Scrutiny/Justification
Required by 4 year institution

Requisite Type
Concurrent

Requisite
MATH M35 - Applied Differential Equations

Requisite Description
Course not in a sequence

Level of Scrutiny/Justification
Required by 4 year institution

Student Learning Outcomes (CSLOs)

	Upon satisfactory completion of the course, students will be able to:
1	recognize, recall, and apply the equations that describe resistive, alternating current, and transient circuits and operational amplifiers such as Ohm's law, Kirchoff's laws, Wye-delta transformations, nodal and mesh analysis, Thevenin and Norton equivalent circuits, and sinusoidal steady-state analysis.
2	analyze and synthesize solutions to electrical circuit problems of reasonable complexity, and evaluate the results according to electrical engineering concepts and principles.
3	use a computer to design and analyze electrical circuits of average complexity appropriate for the course.

Course Objectives

	Upon satisfactory completion of the course, students will be able to:
1	analyze DC circuits to find current, voltage, resistance, power, and/or energy.
2	draw and label circuit diagrams and show thorough mathematical solutions.
3	apply different circuit analysis techniques and demonstrate a process for selecting an appropriate technique for a given problem.
4	solve circuits containing two or more operational amplifiers (Op Amps).
5	find the transient response and complete response for resistor-capacitor (RC), resistor-inductor (RL), and RLC circuits involving DC sources.
6	solve AC circuits by using phasors.
7	calculate average and complex power for AC circuits.

Course Content

Lecture/Course Content

1. **(25%) - Fundamental concepts of resistive circuits**
   a. Ohm's law, electrical power and energy, series and parallel combinations, voltage and current division, Kirchhoff's laws, wye-delta transformations, dependent sources, nodal and mesh analysis, Thevenin and Norton equivalent circuits
   b. Direct Current Personal Simulation Program with Integrated Circuit Emphasis (PSPICE) analysis
2. **(15%) - Frequency response of first and second order AC circuits**

   a. Variable-frequency response analysis
   b. Resonant circuits
   c. Filter networks
3. **(10%) - Operational Amplifiers (Op Amp)**
   a. Analysis using ideal models, voltage gain and current limitations of non-ideal models
   b. PSPICE analysis
4. **(20%) - Alternating current (AC) circuit analysis**
   a. Sinusoidal steady-state analysis including phasors, complex impedance and power factor, average and instantaneous power, power transfer and power factor correction, Kirchhoff's laws, single phase, three phase, and polyphase circuits connections
   b. AC PSPICE analysis
5. **(15%) - Fundamental concepts of transient circuits**
   a. Capacitors and inductors
   b. Resistor-capacitor (RC), resistor-inductor (RL), and resistor-inductor-capacitor (RLC) circuits
   c. Phasors
   d. PSPICE analysis
6. **(15%) - Application of principles of superposition and Laplace Transform for circuit analysis**

Laboratory or Activity Content

Not applicable.

Methods of Evaluation

Which of these methods will students use to demonstrate proficiency in the subject matter of this course? (Check all that apply):

Problem solving exercises
Skills demonstrations

Methods of Evaluation may include, but are not limited to, the following typical classroom assessment techniques/required assignments (check as many as are deemed appropriate):

Classroom Discussion
Computational homework
Group projects
Individual projects
Objective exams
Projects
Problem-solving exams
Participation
Quizzes
Reports/papers
Research papers
Skills demonstrations
Simulations

Instructional Methodology

Specify the methods of instruction that may be employed in this course

Audio-visual presentations
Collaborative group work
Class activities
Class discussions
Demonstrations
Group discussions
Guest speakers
Instructor-guided interpretation and analysis
Instructor-guided use of technology
Internet research
Lecture
Small group activities

Describe specific examples of the methods the instructor will use:

Instructor will use PowerPoint presentation, class discussions, small group activity, and classroom demonstration to explain course content. In addition, the instructor will model problem solving, and show how to interpret and analyze the verbal and graphical information provided in each problem. Furthermore, the instructor will help students develop a sense for evaluating the reasonableness of their computed answers to the problems.

Representative Course Assignments

Writing Assignments

1. Complete problem solving exam questions, such as: (1) A sinusoidal voltage is given by the expression v = 10 cos (3769.91t - 53.13 degrees). Find (a) frequency in hertz; (b) period of the voltage in milliseconds; (c) the smallest positive value of t at which v=0; (d) the rms value of v; (e) the phase angle in degrees and radians.

2. Answer concept questions from lectures, such as: There are five ideal basic circuit elements. Name each element and discuss its characteristics. What is an operational amplifier and how does it work? Explain briefly how a typical household distribution circuit works.

Critical Thinking Assignments

1. Apply knowledge of mathematics, physics, and engineering to derive formulas used in electric circuit analysis. An example would be: Using the general solution method for natural and step responses of RL and RC circuits, derive a numerical expression for the voltage across the capacitor of a RC circuit that has sequential switching.

2. Analyze problems and synthesize solutions in electrical engineering and critically evaluate the results. An example would be: As an engineering graduate you may have the opportunity to serve as an expert witness in lawsuits involving either personal injury or property damage. Consider the following event. At the end of a day of fieldwork, a farmer returns to his farmstead, checks his hog confinement building and finds that the hogs are dead. The problem is traced to a blown fuse that caused a 240 V fan motor to stop. The loss of ventilation led to the suffocation of the livestock. The interrupted fuse is located in the main switch that connects the farmstead to the electrical service. Before the insurance company settles the claim, it wants to know if the electric circuit supplying the farmstead functioned properly. The lawyers for the insurance company are puzzled because the farmer's wife was able to watch TV during the afternoon and when she went in the kitchen during the evening to prepare dinner, the electric clock indicated the correct time. The lawyers have hired you to explain: (1) why the electric clock in the kitchen and the TV set in the living room continued to operate after the main switch blew and (2) why the second fuse in the main switch did not blow after the fan motor stalled.

Reading Assignments

1. Read and study selected chapters from the textbook and the accompanying lecture notes, then answer questions or solve problems assigned by the instructor. An example would be: Read the chapter on Transient Circuits and answer the following question. A parallel plate capacitor of Capacitance C is connected to a battery of voltage V . If the separation of the plates d is doubled while connected to the battery, what is the fractional change in the electrical energy of the capacitor?

2. Read scientific and technical journal articles to expand understanding of the application of electrical engineering theories in academic research and industry.

Skills Demonstrations

1. Demonstrate the ability to read and analyze circuit diagrams, such as: Given the schematic diagram of a simple circuit, use Ohm's Law and Kirchhoff's Laws to find (a) the unknown current and voltage across a resistor; (b) the total power delivered to the resistors; (c) the total power dissipated in the circuit.

2. Demonstrate the ability to use PSPICE to analyze either a DC or an AC circuit.

Outside Assignments

Representative Outside Assignments

1. Homework assignments consisting of circuit problems which correspond to the various lecture topics covered in class. For each lecture topic listed in the course content section, the assignment will include at least ten problems, three of which will be of greater than average difficulty which will require analysis tools beyond the textbook, namely PSPICE. An example would be: The switch in the accompanying circuit (schematic shown) has been closed for a long time before opening at t=0. Find the voltage through the 5 mH inductor for t>0.

2. Design problems which may include library and/or Internet research, application of principles of simple resistive, RC, RL, RLC , and AC circuits, various circuit analysis techniques covered in the course, and appropriate calculations. An example would be: It is often desirable in designing an electric wiring system to be able to control a single appliance from two or more locations, for example, to control a lighting fixture from both the top and bottom of a stairwell. In home wiring systems, this type of control is implemented with 3-way and 4-way switches. A 3-way switch is a three-terminal, two-position switch, and a 4-way switch is a four-terminal, two-position switch. The switches are shown schematically in accompanying figures. (a) Show how two 3-way switches can be connected in a circuit so that a lamp can be turned ON or OFF from two locations. (b) Show how one 4-way switch plus two 3-way switches can be connected to control the lamp from three locations.

Articulation

C-ID Descriptor Number

ENGR 260

Status

Approved

Equivalent Courses at 4 year institutions

University	Course ID	Course Title	Units
Cal Poly San Luis Obispo	EE 201	Electric Circuit Theory	3
CSU San Bernardino	PHYS 150	Introductory Electronics	3
CSU Chico	EECE 211	Linear Circuits I	3
University of California, Los Angeles	EL ENGR 10	Circuit Analysis I	4
University of California, Davis	ENG 17	Circuits I	4
California State University Los Angeles	EE 2040	Circuit Analysis I	3
California State University Northridge	EE 240	Electrical Engineering Fundamentals	3

Comparable Courses within the VCCCD
ENGR V16 - Electronic Circuits & Devices

District General Education

A. Natural Sciences

B. Social and Behavioral Sciences

C. Humanities

D. Language and Rationality

E. Health and Physical Education/Kinesiology

F. Ethnic Studies/Gender Studies

Course is CSU transferable
Yes

CSU Baccalaureate List effective term:
Fall 1995

CSU GE-Breadth

Area A: English Language Communication and Critical Thinking

Area B: Scientific Inquiry and Quantitative Reasoning

Area C: Arts and Humanities

Area D: Social Sciences

Area E: Lifelong Learning and Self-Development

CSU Graduation Requirement in U.S. History, Constitution and American Ideals:

UC TCA

UC TCA
Approved

IGETC

Area 1: English Communication

Area 2A: Mathematical Concepts & Quantitative Reasoning

Area 3: Arts and Humanities

Area 4: Social and Behavioral Sciences

Area 5: Physical and Biological Sciences

Area 6: Languages Other than English (LOTE)

Textbooks and Lab Manuals

Resource Type
Textbook

Classic Textbook
No

Description
Nilsson, James W., and Susan A. Riedel. *Electric Circuits.* 11th ed. Pearson, 2019.

Resource Type
Textbook

Classic Textbook
No

Description
Irwin, J. David, and Robert M. Nelms. *Basic Engineering Circuit Analysis,.* 11th ed. Wiley, 2015.

Resource Type
Textbook

Classic Textbook
No

Description
Alexander, Charles K., and Matthew N. O. Sadiku. *Fundamentals of Electric Circuits.* 6th ed. McGraw-Hill, 2016.

Resource Type
Textbook

Classic Textbook
No

Description
Hayt, William H., Jack E. Kemmerly, and Steven M. Durbin. *Engineering Circuit Analysis*. 8th ed. McGraw-Hill, 2011.

Resource Type
Software

Description
PSpice. Cadence, 9.1 ed.

PSpice is an acronym for Personal Simulation Program with Integrated Circuit Emphasis. This simulation program is for Microsoft Windows. http://www.cadencepcb.com/ http://www.electronicslab.com/downloads/schematic/013/

Library Resources

Assignments requiring library resources
Writing, reading, critical thinking, and outside assignments

Sufficient Library Resources exist
Yes

Example of Assignments Requiring Library Resources
Research, using the Library's print and online resources, in particular Elsevier's ScienceDirect Database, to find articles on DC, AC, and transient circuits and their applications in research and industry to solve problems and expand understanding of these electrical systems.

Primary Minimum Qualification
ENGINEERING

Review and Approval Dates

Department Chair
10/31/2019

Dean
10/31/2019

Technical Review
11/07/2019

Curriculum Committee
11/19/2019

DTRW-I
12/12/2019

Curriculum Committee
MM/DD/YYYY

Board
01/21/2020

CCCCO
01/28/2020

Control Number
CCC00061247

DOE/accreditation approval date
MM/DD/YYYY