Lecture 0

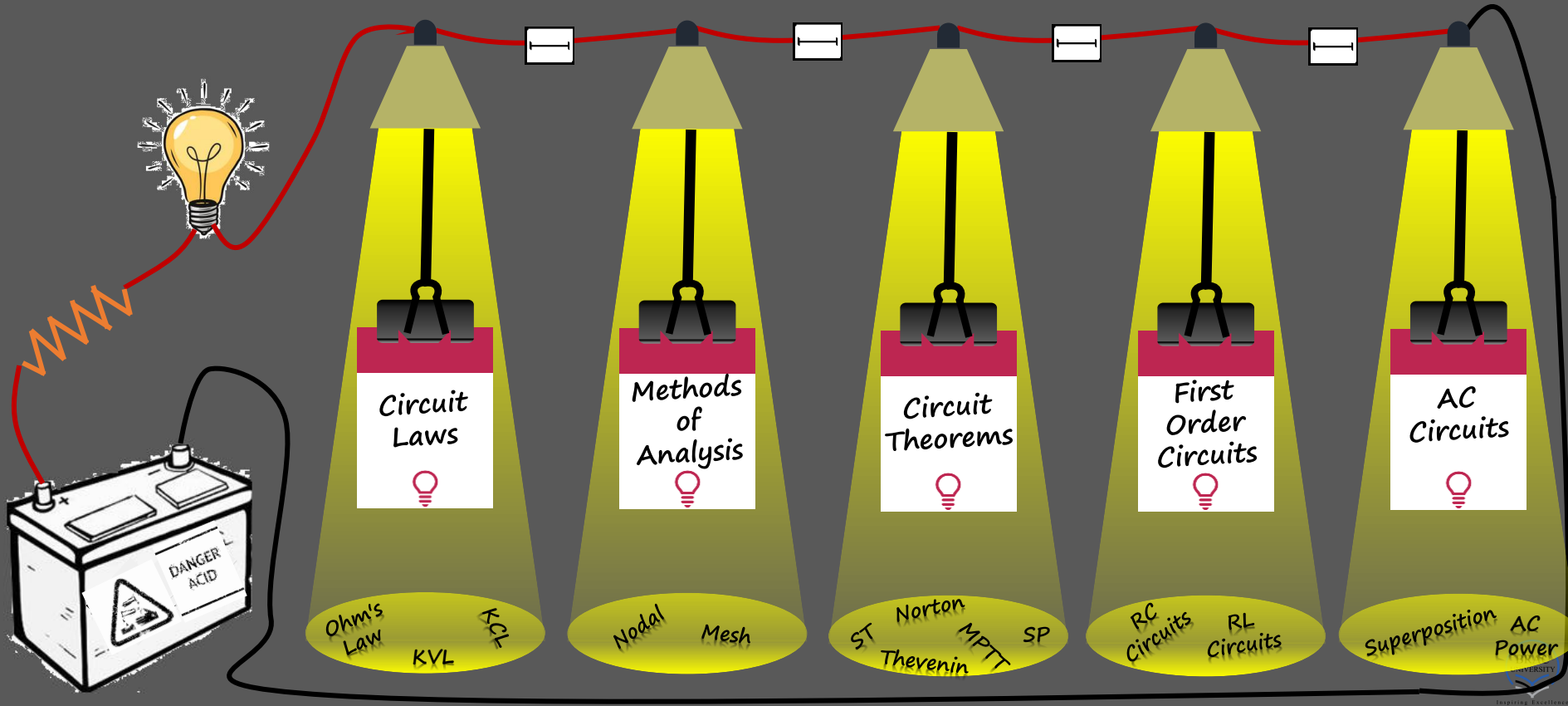CSE250 – Circuits and Electronics

INTRODUCTION TO CSE250

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Course Contents

- Fundamental electrical concepts and measuring units of electrical charge, voltage, current, resistance, and power; Laws of electricity (Ohm's law, Kirchhoff's Current and Voltage law) and various methods of electrical circuit analysis (Nodal, Mesh); Introduction to basic electrical circuit elements; I-V characteristics; Circuit analysis in Direct current, First-order Transient and Alternating current mode, for various combinations of Resistive, Inductive and Capacitive networks; Phasor representation of sinusoidal quantities; Circuit theorems for linear circuits (Source Transformation, Superposition, Thevenin, Norton and Maximum Power Transfer).

- This course includes compulsory 3-hour laboratory work.

Course Outline: broad themes

Circuit Laws

Ohm's Law
KCL
KVL

Methods of Analysis

Nodal
Mesh

Circuit Theorems

ST
Norton
Thevenin
MPTT
SP

First Order Circuits

RC Circuits
RL Circuits

AC Circuits

Superposition
AC Power

DANGER ACID

Course Objectives

- Introduce students to ideal linear electrical circuit components such as dependent and independent voltage and current sources, resistors, capacitors and inductors and their characteristic equations.

- Illustrate the $I - V$ characteristics of any two-terminal devices and infer circuit equivalence.

- Define physical quantities related to electricity such as voltage, current and power and introduce passive sign convention for computing these quantities.

- Explain fundamental laws like Ohm's law, Kirchhoff's voltage and current law, as well as important linear circuit theorems such as Thevenin's and Norton's theorem, maximum power transfer theorem, superposition principle, and source transformation.

- Familiarize students with several circuit-solving techniques aside from the circuit theorems, such as the voltage/current divider rule, series-parallel circuit equivalence, and nodal and mesh analysis, that take advantage of the fundamental laws and theorems of the linear circuit.

- Analyze first-order transient circuits with resistors, capacitors and inductors in the time domain.

- Introduce operational amplifiers and their use in mathematical computations.

- Introduce phasors and analyze alternating current (AC) circuits constructed from sinusoidal sources, resistors, capacitors and inductors in the phasor domain.

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Course Outcomes

Upon successful completion of this course, you will be able to,

Sl.	CO Description	Weightage (%)
CO1	**Understand** and **Describe** the foundational concepts of electricity, including relevant physical quantities and the governing laws that dictate its behavior, such as Kirchhoff's current and voltage law, Ohm's law, etc.	10
CO2	**Describe** linear circuit theorems, such as the superposition principle, source transformation, Thevenin and Norton's theorem, and maximum power transfer theorem, and demonstrate the ability to **Apply** them efficiently.	35
CO3	**Analyze** the behavior of analog electrical circuits constructed from networks of diverse linear elements by utilizing various tools, including nodal and mesh analysis, circuit equivalence, voltage and current divider rules, and phasors domain analysis.	35
CO4	**Develop** hands-on circuit-building and troubleshooting skills by collaborating in groups to perform lab tasks, utilizing laboratory equipment, such as oscilloscopes, function generators, and multimeters to measure, verify, and troubleshoot analog circuits.	12
CO5	Collaborate effectively in a group in the laboratory, and **Report** their findings and insights clearly and concisely, using technical language and documentation standards.	3
CO6	**Demonstrate** individual competence in using laboratory equipment, such as oscilloscopes, function generators, and multimeters, to build, test, and verify analog circuits, as well as troubleshoot circuit problems.	5

Lesson Plan - 1/2

No	Topic	Lecture #
1	Illustrating the motivation behind taking this course. What are the real-life implications of these course materials?	Lecture 1
2	Discuss basic circuit parameters like voltage, current, energy and power definitions and units. Introducing passive sign convention, positive-negative voltage/current/power. Discuss different types of circuit elements (active, passive), and different types of sources (DC/AC, voltage/current, dependent/independent). Introducing circuit symbols.	Lecture 2
3	Introducing basic electrical components: resistors, voltage source, current source. Basic laws of electrical circuits: Ohm's law. I-V characteristics of a resistor. Discuss passive sign convention, finding power of circuit elements by P=VI. Defining nodes, loops and mesh. Discuss various circuit configurations: Series, Parallel and others. How to identify series and parallel connections and calculate equivalent resistance. Open and short circuit.	Lecture 3
4	Defining Node/Supernode. Introducing Current Sign Convention. Basic laws of electrical circuits: Kirchhoff's current law. Statement and application of KCL. Current divider rule in a parallel circuit. Illustrating convention doesn't change the KCL equation. Show usefulness of supernode.	Lecture 4

5	Defining Mesh/Supermesh. Revisiting Passive Sign Convention. Basic laws of electrical circuits: Kirchhoff's voltage law. Statement and application of KVL. Voltage divider rule in a series circuit. Illustrating the assumption of the current direction doesn't change the KVL equation. Show usefulness of supermesh.	Lecture 5
6	I-V characteristics of basic circuit elements: Resistor, Voltage source, Current source, Open circuit, Short circuit, any two-terminal device/circuit, a combination of elements (e.g. voltage/current source in series/parallel with resistor). Idea of circuit equivalence. Series-parallel equivalent circuit for resistance/voltage source/current source combinations. Ideal/non-Ideal current/voltage source. Simplifying circuits by means of equivalence. Basic circuit theorem: Source Transformation theorem. Failure of applying in Wheatstone bridge circuit.	Lecture 6
	Quiz 1	
7	Explaining Nodal Analysis technique, using it to solve for current, voltage, and power in a given circuit (multiple examples).	Lecture 7
8	Reintroducing dependent sources. Demonstrating Nodal Analysis with dependent sources. Problems with floating voltage sources, using Supernodes to solve such circuits. Explaining MeshAnalysis technique, using it to solve for current, voltage, and power in a given circuit (multiple examples).	Lecture 8

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Lesson Plan - 2/2

9	Demonstrating Mesh Analysis with dependent sources. Problems with common current sources, using Supermeshes to solve such circuits.	**Lecture 9**
10	Linear circuit elements. Linearity of voltage, current in circuits, and non-linearity of power. Circuit theorem: Superposition theorem. Using superposition theorem for solving DC circuits. Superposition Theorem for circuits with Dependent Sources.	**Lecture 10**
Quiz 2		
Midterm		
11	Reintroduction to circuit linearity, I-V characteristics of linear circuits. Circuit Theorems: Thevenin's theorem. The motivation behind Thevenin's theorem.	**Lecture 11**
12	Using test voltage/current sources while deactivating sources to find Thevenin's. Solving resistance matching problems for transferring maximum power. Norton's theorem, the relation between Thevenin's and Norton's theorem.	**Lecture 12**
13	Using Thevenin's/Norton's theorem for solving circuits. Maximum transferable power and condition for it.	**Lecture 13**
Quiz 3		

14	Capacitors and Inductors, their component equations. SI unit for measuring capacitance and inductance. Transient circuits, visualizing and analyzing transient circuits.	**Lecture 14**
15	Response of transient circuit: first order RC circuit, time constant. Analyzing and plotting first-order transient circuit response. Finding capacitor current from capacitor voltage	**Lecture 15**
16	Response of transient circuit: first order RL circuit, time constant. Analyzing and plotting first-order transient circuit response. Finding inductor voltage from inductor current.	**Lecture 16**
17	Complex number review. Alternating current, the importance of AC circuit. Visualizing the dynamics of an AC circuit, Amplitude, RMS voltage/current and finding them from a graph.	**Lecture 17**
18	Introducing Impedance. Defining impedance for various elements, Phasor analysis of an AC circuit. Instantaneous voltage, current and power. Applying superposition theorem on AC circuits containing sources of different frequencies	**Lecture 18**
Quiz 4		
Final Exam		

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Course Materials

- Text and reference books

Sl.	Title	Author(s)	Publication Year	Edition	Publisher	ISBN
1	Fundamentals of Electric Circuits	Charles K. Alexander, Matthew N. O. Sadiku	2019	6th	McGraw Hill Education	978-9353165505
2	Introductory Circuit Analysis	Robert L. Boylestad	2013	12th	Pearson Education India	978-9332518612
3	Electric Circuits	James W. Nilsson Susan A. Riedel	2010	9th	Pearson College Div	978-0136114994

- Other materials

  ➢ Lecture Slides   ➢ Practice Problems   ➢ Previous Semesters' Mid and Final Questions

  ➢ Video Lectures   ➢ Suggested Problems   ➢ Lab Sheets and Manuals   ➢ Lab Recordings

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Mark Distribution††

Assessment	Criteria	Weightage (%)
Attendance	≥ 70% to attend final exam	5
Assignment	2 to 4	5
Quiz	Best 3 out of 4	15
Midterm	Central Exam	25
Final	Central Exam	25
Lab	Hardware Experiments	25
Total		100

Assessment	Criteria	Weightage (%)
Attendance	≥ 90% to attend final exam	2
Lab performance	7 experiments	5
Lab reports	2 Hardware	6
Lab tests	2 Hardware	12
Total		25

†† Mark distribution may change depending on the number of classes and syllabus for a semester.

Contact

- **Faculty Information**
  - Full Name:
  - Initial:

- **Contact**
  - Email: @bracu.ac.bd
  - Desk:

- **Consultation Hours**†
  - Sunday, Tuesday: 11:00 AM – 12:30 PM
  - Monday, Wednesday: 12:30 PM – 2:00 PM

† Consultation is not makeup of any class. Specific concepts/theories/analytical problems/issues may be discussed.

Thank you for your attention