Chapter 1

Passive Sign Convention

Chapter 2

Resistors

Chapter 3

Nodal Analysis

Chapter 4

Mesh Analysis

Chapter 5

Operational Amplifiers

Chapter 6

Capacitors

Chapter 7

Inductors

Inductors are largely related to magnetic fields, as they store energy in the induced magnetic field created when current runs through them.

7.1 Magnetic Field Contributions From Current Carrying Wires

Biot-Savart Law

From a current-carrying wire, each infinitesimally small part of wire contributes to the total magnetic field at a given point. The magnetic field is referred to as **H**. This small contribution is given by:

$$d\overrightarrow{H} = \frac{I * d\overrightarrow{l} \times \overrightarrow{R}}{4\pi R^2} \tag{7.1}$$

where I is the current in the wire (in amps), d$\overrightarrow{l}$ is the "piece" of wire (in meters), $\overrightarrow{R}$ is the direction vector from the "piece" of wire to the point of the magnetic field (unitless), and R is the distance from the wire "piece" to the point (in meters)

Equation 7.1.1: Partial Contribution to Magnetic Field From a Current-Carrying Wire

Therefore the total magnetic field at a given point from a current-carrying wire is:

$$\overrightarrow{H} = \int \frac{I * d\overrightarrow{l} \times \overrightarrow{R}}{4\pi R^2} \tag{7.2}$$

Equation 7.1.2: Total Magnetic Field at a Given Point from a Current-Carrying Wire

The units of $\overrightarrow{H}$ is $\frac{amps}{meter}$, which is similar to the units of electric fields, $\overrightarrow{E}$, which is in $\frac{volts}{meter}$

Amperes Law

Ampere stated that if you integrated the magnetic field intensity about a closed path around a current-carrying wire, then it would equal the current enclosed by the wire, given by the formula:

$$\oint \overrightarrow{H} \cdot d\overrightarrow{l} = I_{enclosed} \tag{7.3}$$

Equation 7.1.3: Amperes Law

Forces between current carrying wires also occur due to the induced magnetic fields created by the electrons moving in the wire (the current): this is called the Lorentz Force.

$$\overrightarrow{F} = q(\overrightarrow{E} + \overrightarrow{v} \times \overrightarrow{B}) \tag{7.4}$$

where $\overrightarrow{F}$ is the force (in Newtons), q is charge (in coulombs), $\overrightarrow{E}$ is the electric field, $\overrightarrow{v}$ is the velocity of the charge (in meters/second, and $\overrightarrow{B}$ is the magnetic field

Equation 7.1.4: Lorentz Force

7.2 Magnetic Field Intensity and Magnetic Flux Density

Chapter 8

Transients, Steady-States and First Order Circuits

Chapter 9

Steady-State Sinusoidal Analysis

Chapter 10

Sinusoidal AC Power Analysis

Chapter 11

Summary