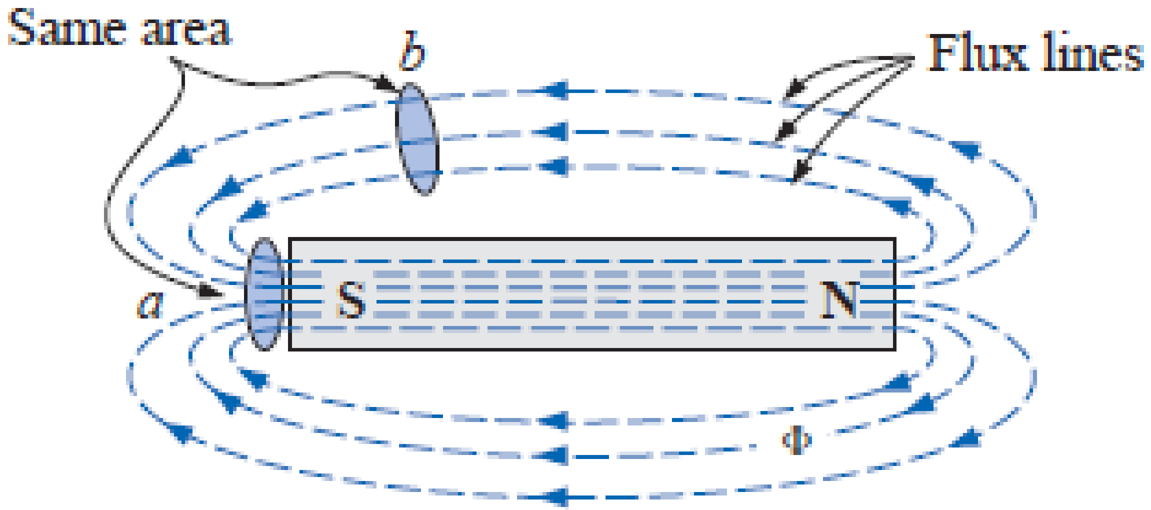
MAGNETIC CIRCUITS

Chapter 10

Introductory Circuit Analysis by Robert L. Boylestad

Magnetic Fields



Flux Density

- Magnetic flux is measured in *webers* and has the symbol Φ*.* The number of flux lines per unit area is called the **flux density,** is denoted by the capital letter *B,* and is measured in *teslas*. Its magnitude is determined by the following equation:
- $B = \frac{\phi}{A}$

Permeability

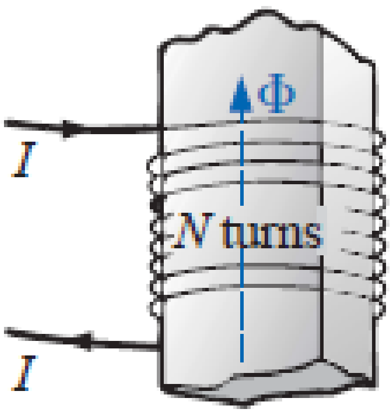
- The **permeability** (μ) of a material is a measure of the ease with which magnetic flux lines can be established in the material. It is similar in many respects to conductivity in electric circuits. The permeability of free space μ_0(vacuum) is
- $\mu_0 = 4\pi \times 10^{-7} \frac{Wb}{A.m}$
- The ratio of the permeability of a material to that of free space is called its **relative permeability;** that is,
- $\mu_r = \frac{\mu}{\mu_0}$

Reluctance

- The **reluctance** of a material to the setting up of magnetic flux lines in the material is determined by the following equation:
- $\Re = \frac{l}{\mu A}$ (rels, or At/Wb)

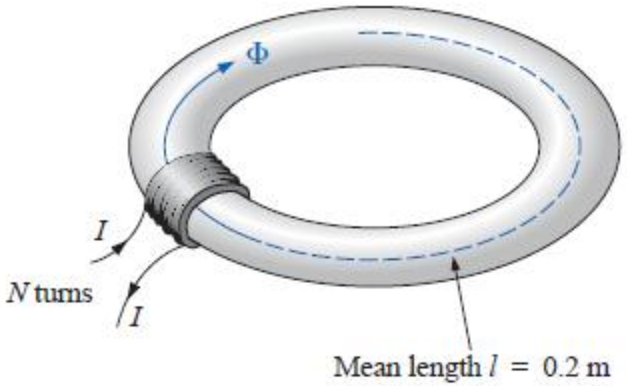
Ohm's Law for Magnetic Circuit

- The magnetomotive force $\mathfrak{F}$ is proportional to the product of the number of turns around the core (in which the flux is to be established) and the current through the turns of wire. In equation form,
- $\mathfrak{F} = NI$(ampere-turns, At)

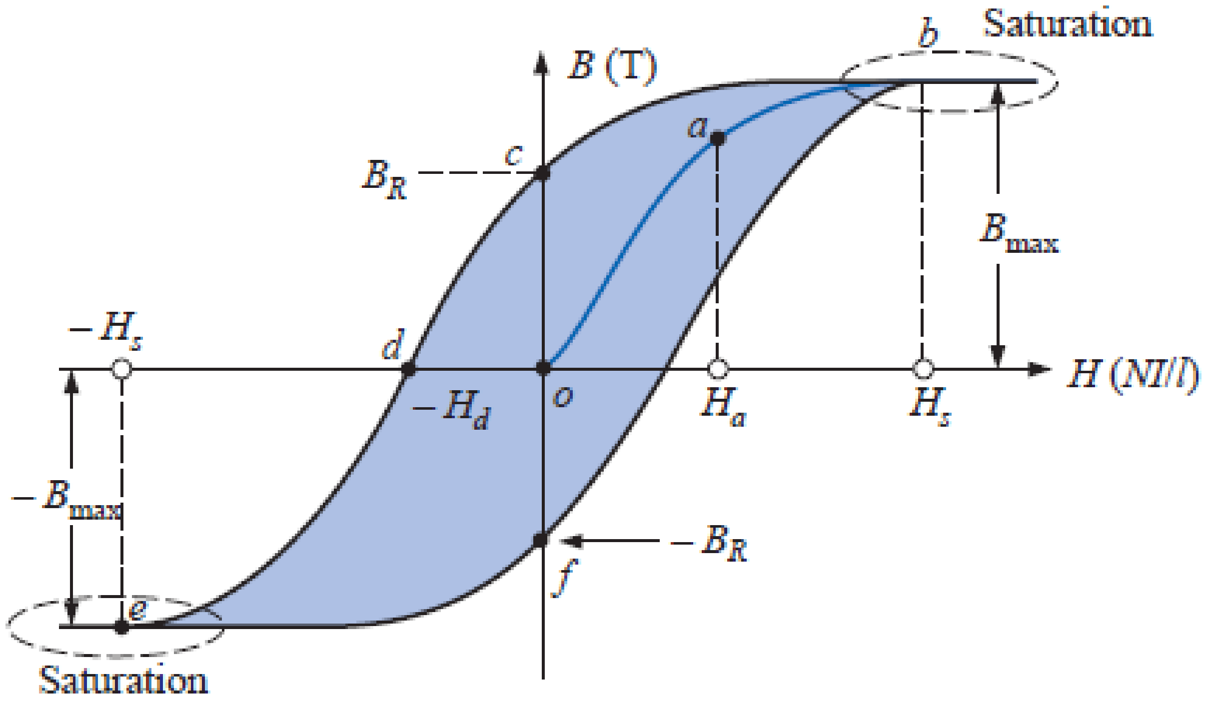


Magnetizing Force

- The magnetomotive force per unit length is called the **magnetizing force** (*H*). In equation form,
- $H = \frac{\mathfrak{F}}{l}$ (At/m)



Hysteresis



Saturation
b
B (T)
a
c
B_R
B_{max}
$-H_s$
d
H (NI/l)
$-H_d$
o
H_a
H_s
$-B_{max}$
$-B_R$
f
e
Saturation

Ampere’s Circuital Law

- It states that the algebraic sum of the rises and drops of the mmf around a closed loop of a magnetic circuit is equal to zero; that is, the sum of the rises in mmf equals the sum of the drops in mmf around a closed loop.
- $\sum_{\circlearrowleft} \mathfrak{F} = 0$