ECE343 Spring 2025

Objective 8.3: Maxwell's Equations



UNITED STATES
AIR FORCE
ACADEMY

SCHEDULE

Lesson	Topics	Reading	Notes
24	BVP (Capacitor, Coax), Electric Potential	5.16	LO 5.3
25	Electric Boundary Conditions	5.18-5.22	LO 5.4
26	BC's/Capacitance	5.23-5.24	
27	Electrostatic Lab	Lab packet	
Chapter 6: Steady Current & Conductivity			
28	Current density, Conductivity, Resistance	Ch. 6	
Chapter 7: Magnetostatics			
29	Magnetic Fields, Gauss' Law for Magnetism	7.1-7.3	LO 7.1-7.2 **GR 2**
30	Ampere's Law	7.4-7.5, 7.9	LO 7.3
31	Ampere's Law Applied	7.6-7.8	LO 7.3
32	Magnetic Boundary Conditions	7.10-7.14	LO 7.4
33	Magnetostatics Lab	Lab packet	
Chapter 8: Time-Varying Fields			
34	Faraday's Law, Displacement Current, Maxwell Eqns	8.3, 8.8, 8.9	LO 8.1
35	Faraday's Law, Displacement Current, Maxwell Eqns	8.3, 8.8, 8.9	LO 8.2-8.3
Chapter 9: Plane Waves in Lossless Media			
36	Maxwell's Equations in lossless, source-free region	9.1-9.2	LO 9.1
37	Maxwell's Equations in lossless, source-free region	9.1-9.2	LO 9.1
38	Uniform Plane Waves & Polarization	9.4-9.6	LO 9.2-9.3
39	Normal Incidence	Vol 2, 5.6-5.7	LO 9.4-9.5
40	Oblique Incidence	Vol 2, 5.6-5.7	LO 9.5
41	Oblique Incidence	Vol 2, 5.6-5.7	LO 9.5
42	Incidence Lab	TBD	LO 9.5

Ch 8 Learning Objectives

7.1 I can articulate the significance of the displacement current and calculate it, given a time-varying electric field.

7.2 I can articulate the meaning of and calculate the relaxation time for a variety of materials.

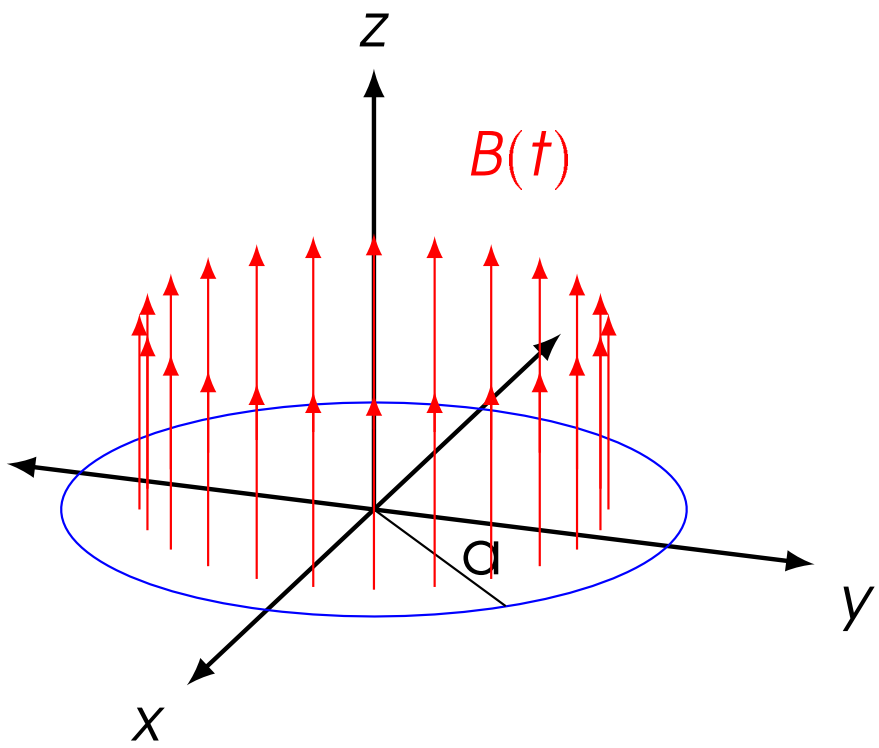
7.3 I know the forms of Maxwell's equations for time-varying fields and use them to calculate electric and magnetic fields for a variety of physical systems.

Maxwell's Equations

Integral Form	Point Form
$\iint \epsilon \vec{E} \cdot d\vec{S} = Q_{enc}$	$\nabla \cdot \vec{E} = \frac{\rho_v}{\epsilon}$
$\oint \vec{H} \cdot d\vec{S} = 0$	$\nabla \cdot \vec{H} = 0$
$\oint_C \vec{E} \cdot d\ell = -\frac{\partial \Psi_m}{\partial t}$ $\oint_C \vec{E} \cdot d\ell = -\iint \frac{\partial \vec{B}}{\partial t} \cdot d\vec{S}$	$\nabla \times \vec{E} = -\mu \frac{\partial \vec{H}}{\partial t}$
$\oint_C \vec{H} \cdot d\ell = I_{encl}$ $\oint_C \vec{H} \cdot d\ell = \int \vec{J} \cdot d\vec{S} + \epsilon \frac{\partial}{\partial t} \iint \vec{E} \cdot d\vec{S}$	$\nabla \times \vec{H} = \sigma \vec{E} + \epsilon \frac{\partial \vec{E}}{\partial t}$

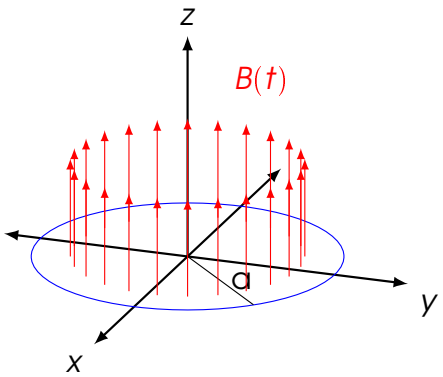
Maxwell's Equations: Example #1

A wire loop of radius $a = 10$cm lies in the $x - y$ plane (i.e., $z = 0$) and contains a small gap with 1kΩ resistor. A time-varying magnetic flux density, $B(t)$ exists, with $t_0 = 3$s and $B_0 = 0.2$T. Determine the potential and current across the resistor.



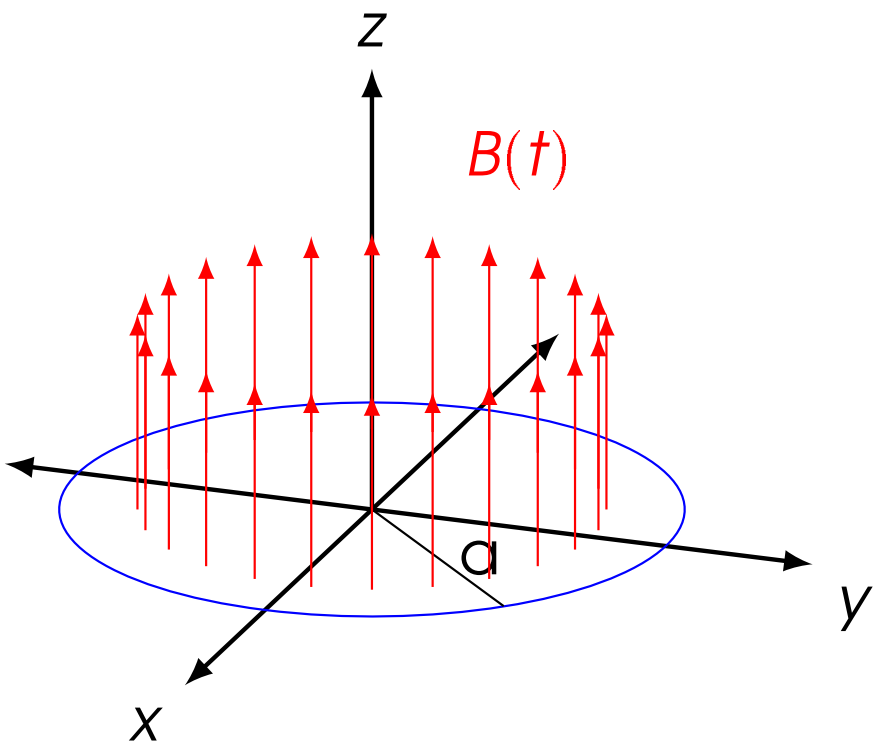
$$B(t) = \begin{cases} 0 & t < 0 \\ \dfrac{B_0}{t_0} & 0 \leqslant t \leqslant t_0 \\ B_0 & t > t_0 \end{cases}$$

Maxwell's Equations: Example #1



Maxwell's Equations: Example #2

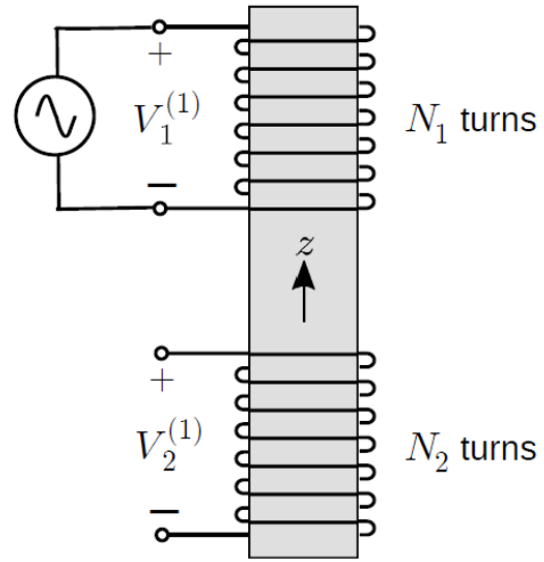
A wire loop of radius $a = 10\text{cm}$ lies in the $x - y$ plane (i.e., $z = 0$) and contains a small gap with 1kΩ resistor. A time-varying magnetic flux density, $B(t)$ exists, with $t_0 = 3\text{s}$ and $B_0 = 0.2\text{T}$. Determine the potential and current across the resistor.

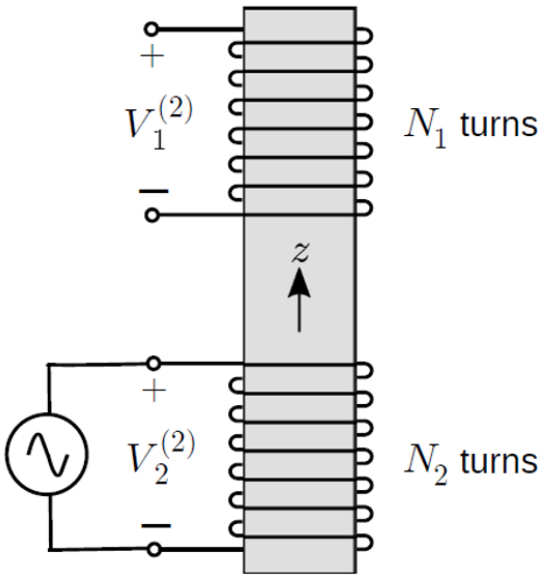


$$B(t) = \sin(2\pi f t) \qquad f_0 = 1\text{kHz}$$

Maxwell's Equations: Example #2

TRANSFORMERS





TRANSFORMERS

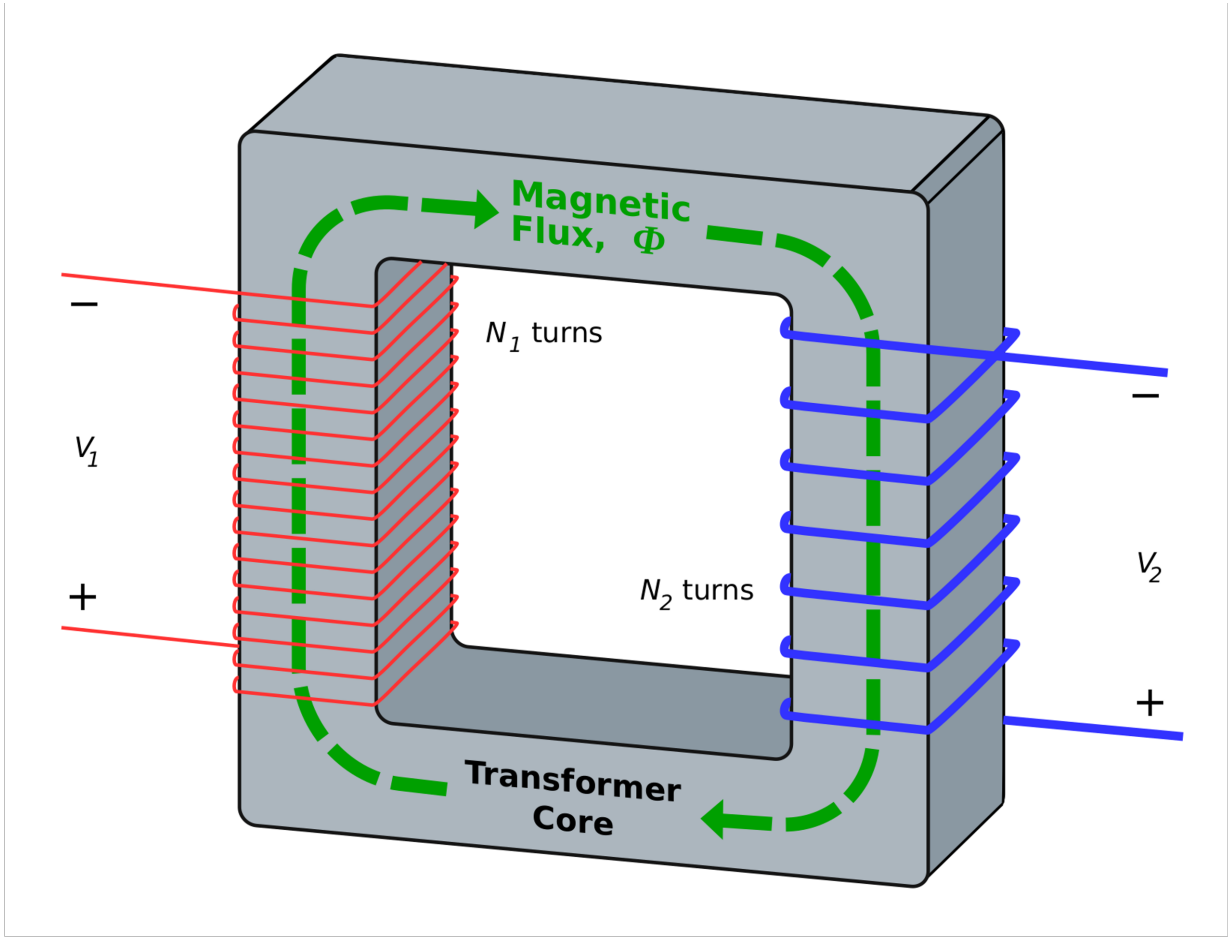


Fig. 8.8: © BillC, https://commons.wikimedia.org/wiki/File:Transformer3d col3.svg, CC BY SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0/). Modified by author.