ECE343 Spring 2025

Objective 7.3: Ampere's Law



UNITED STATES AIR FORCE ACADEMY

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 7 Learning Objectives

7.1 I can use the Biot-Savart law to simple magnetostatic systems to find the magnetic field at an observation point.

7.2 I can articulate the meaning of both the integral form and point form of Gauss' Law for magnetism.

7.3 I can use Ampere's Law to calculate the magnetic field at an observation point for simple magnetostatic systems.

7.4 I can apply the magnetic field boundary conditions to calculate magnetic fields on both sides of a material boundary.

Ampere's Law

Integral Form

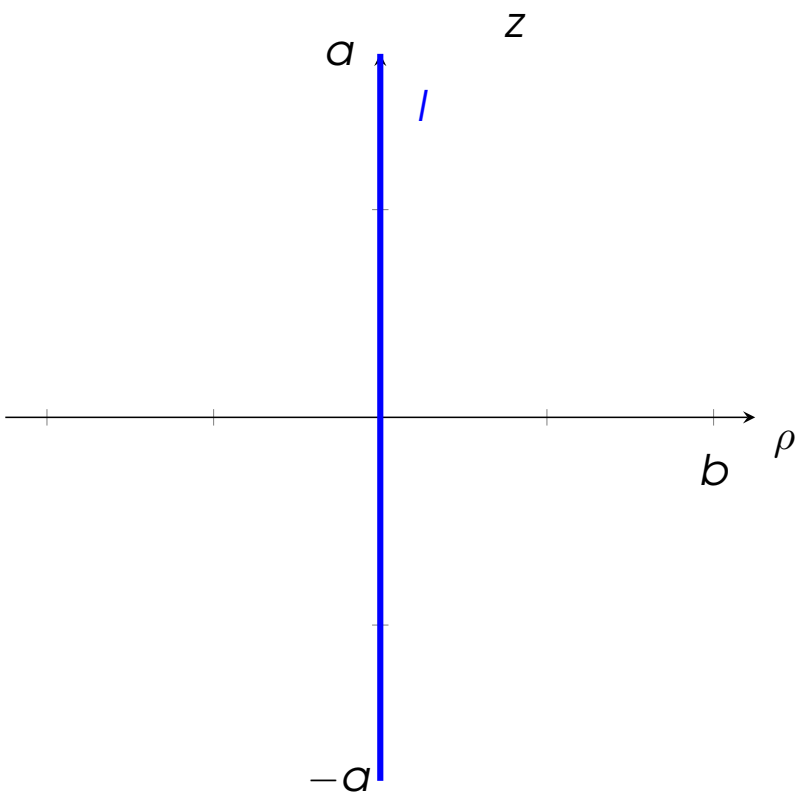
$$\oint_C \vec{H} \cdot d\ell = I_{\text{encl}}$$

Point Form

$$\nabla \times \vec{H} = \vec{J}$$

AMPERE'S LAW: LINE CHARGE

Find $\vec{H}$ at a distance b from the LC.



1

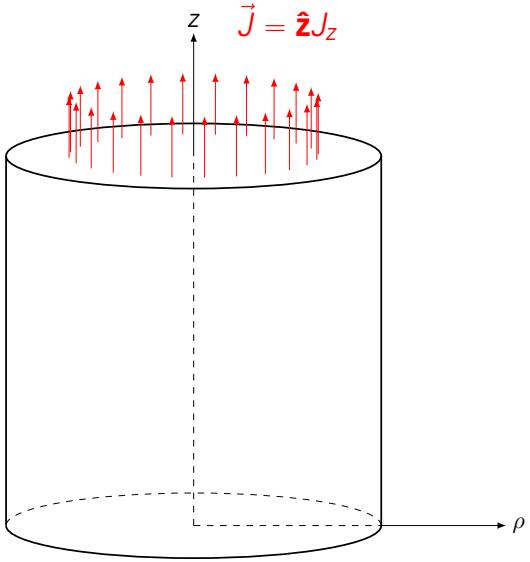
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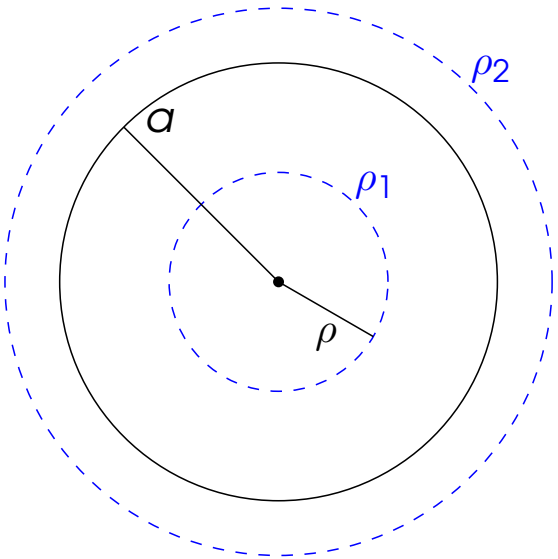
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AMPERE'S LAW: COAXIAL CABLE



1

2



3

4

5

Ampere's Law: Coaxial Cable

Case 1: $\rho < a$

$\rho_0 =$ _____

$H_\phi =$ _____

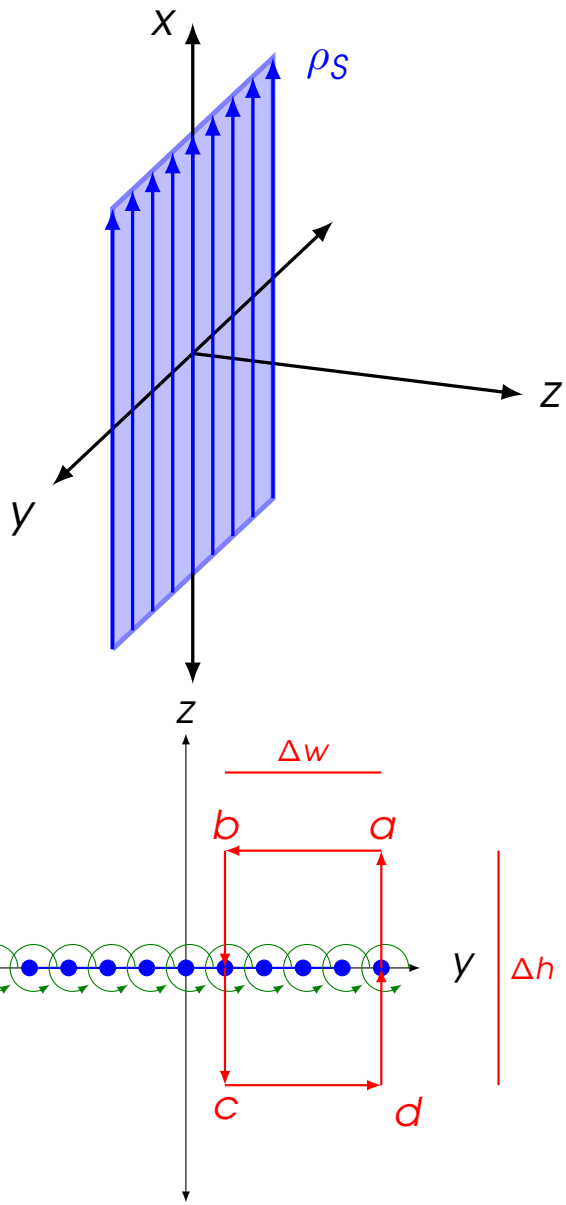
Case 2: $\rho > a$

$\rho_0 =$ _____

$H_\phi =$ _____

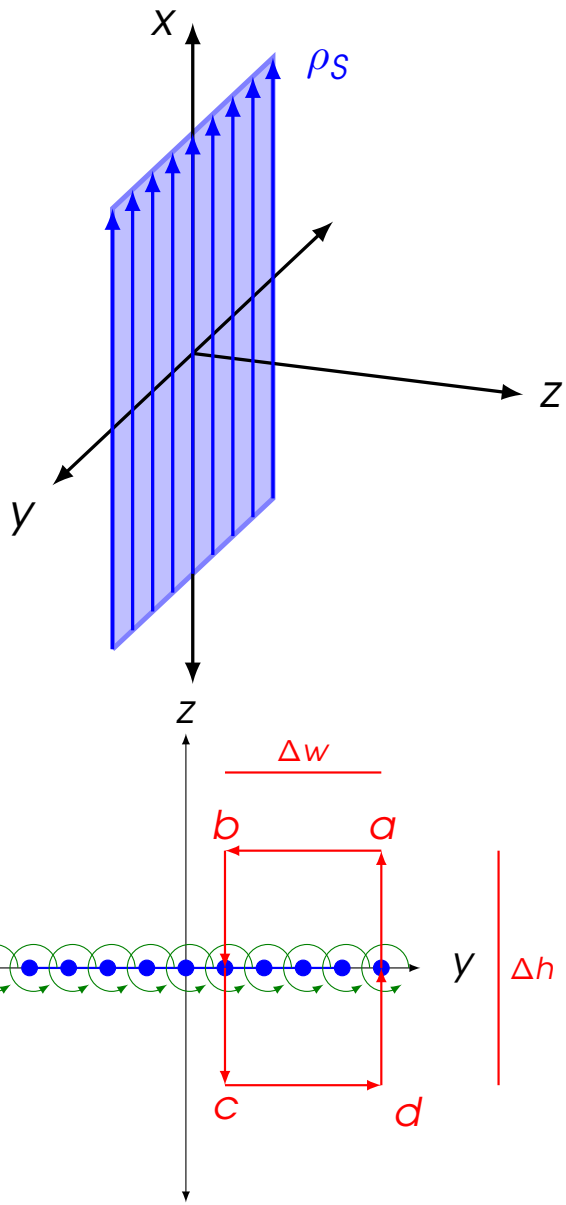
Now, plot H_ϕ...

Ampere's Law: Sheet Charge



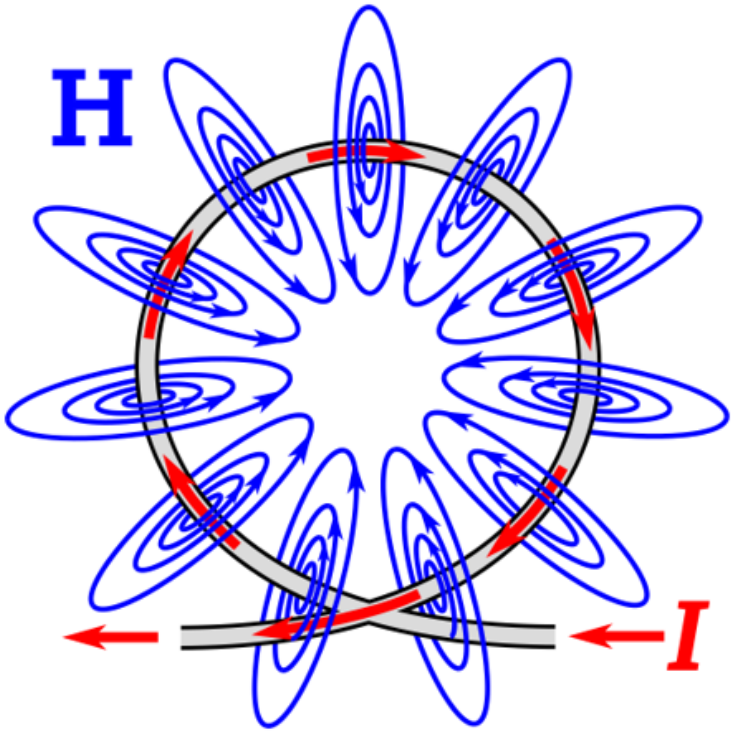
1.
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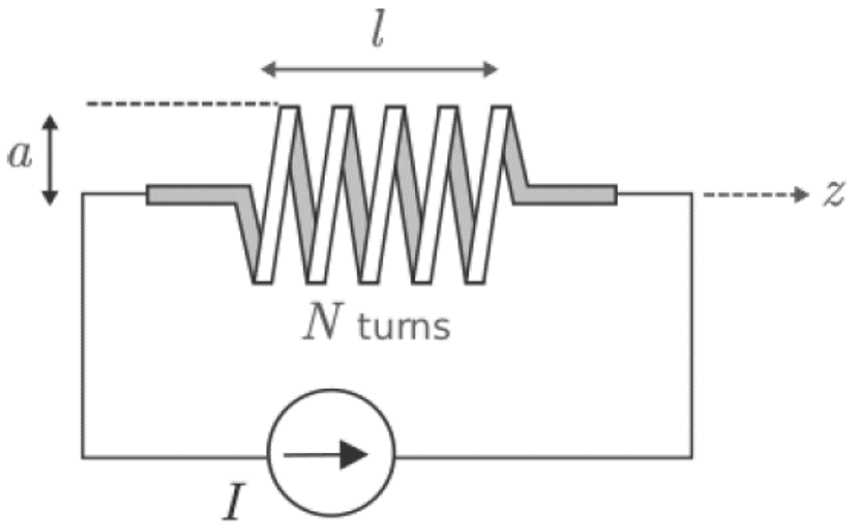
Ampere's Law: Sheet Charge



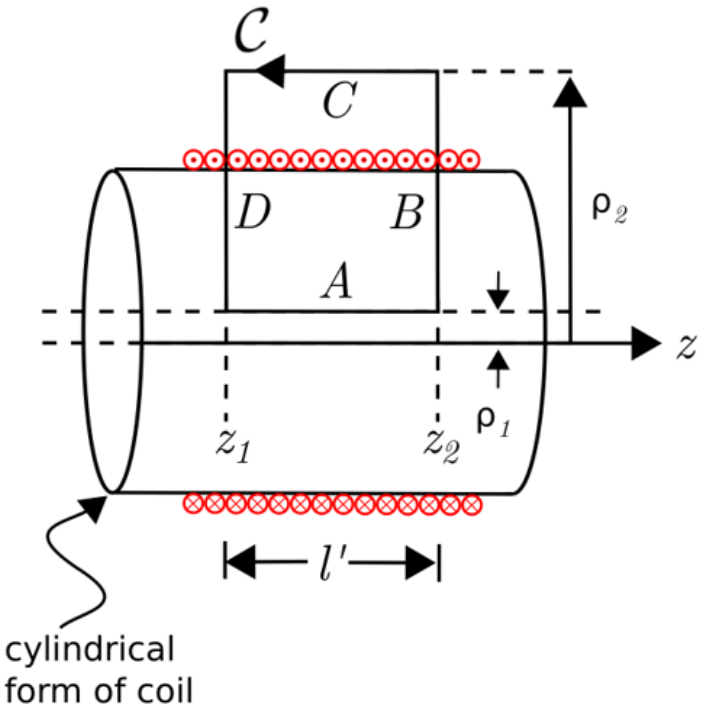
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Ampere's Law: Solenoid





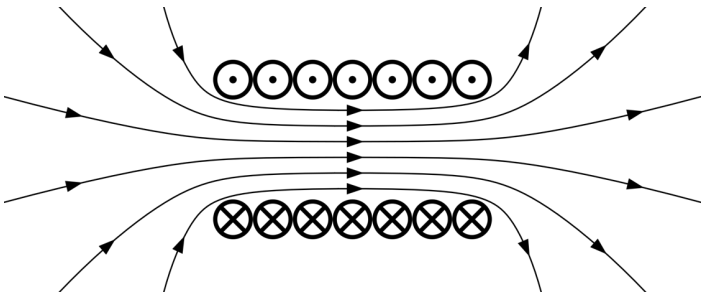
Ampere's Law: Solenoid



1

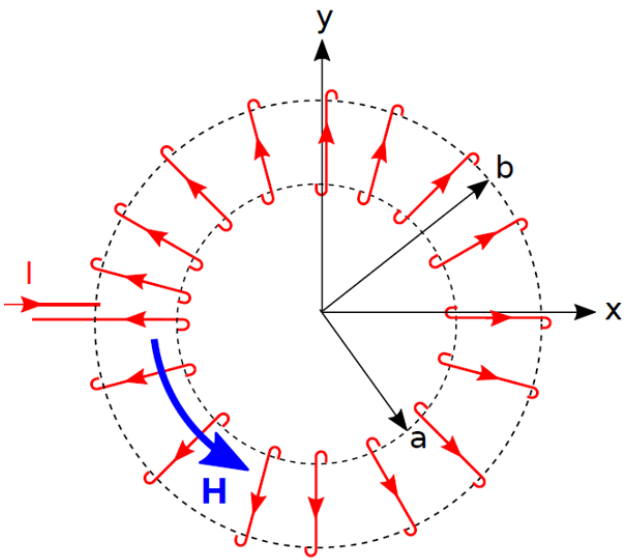
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3

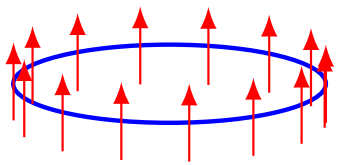


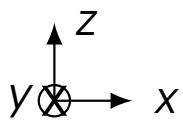
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Ampere's Law: Toroid



Note: the contour of integration is **inside** the core, meaning current through the surface defined by the contour is carried in the windings at the inner edge of the core:





1 2 3 4 5

Maxwell's Equations: Static Fields

Law	Integral Form	Point Form
Gauss's Law for Electricity	$\oint_S \vec{E} \cdot \vec{dS} = \frac{Q_{\text{encls}}}{\varepsilon}$	$\nabla \cdot \vec{E} = \frac{\rho}{\varepsilon_V}$
Gauss's Law for Magnetism	$\oint_S \vec{B} \cdot \vec{dS} = 0$	$\nabla \cdot \vec{B} = 0$
Faraday's Law	$\oint_S \vec{E} \cdot \vec{d\ell} = 0$	$\nabla \times \vec{E} = 0$
Ampere's Law	$\oint_S \vec{H} \cdot \vec{d\ell} = I_{\text{encl}}$	$\nabla \times \vec{H} = \vec{J}$