ECE343 Spring 2025

Objective 7.4: Magnetic Field Boundary Conditions



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

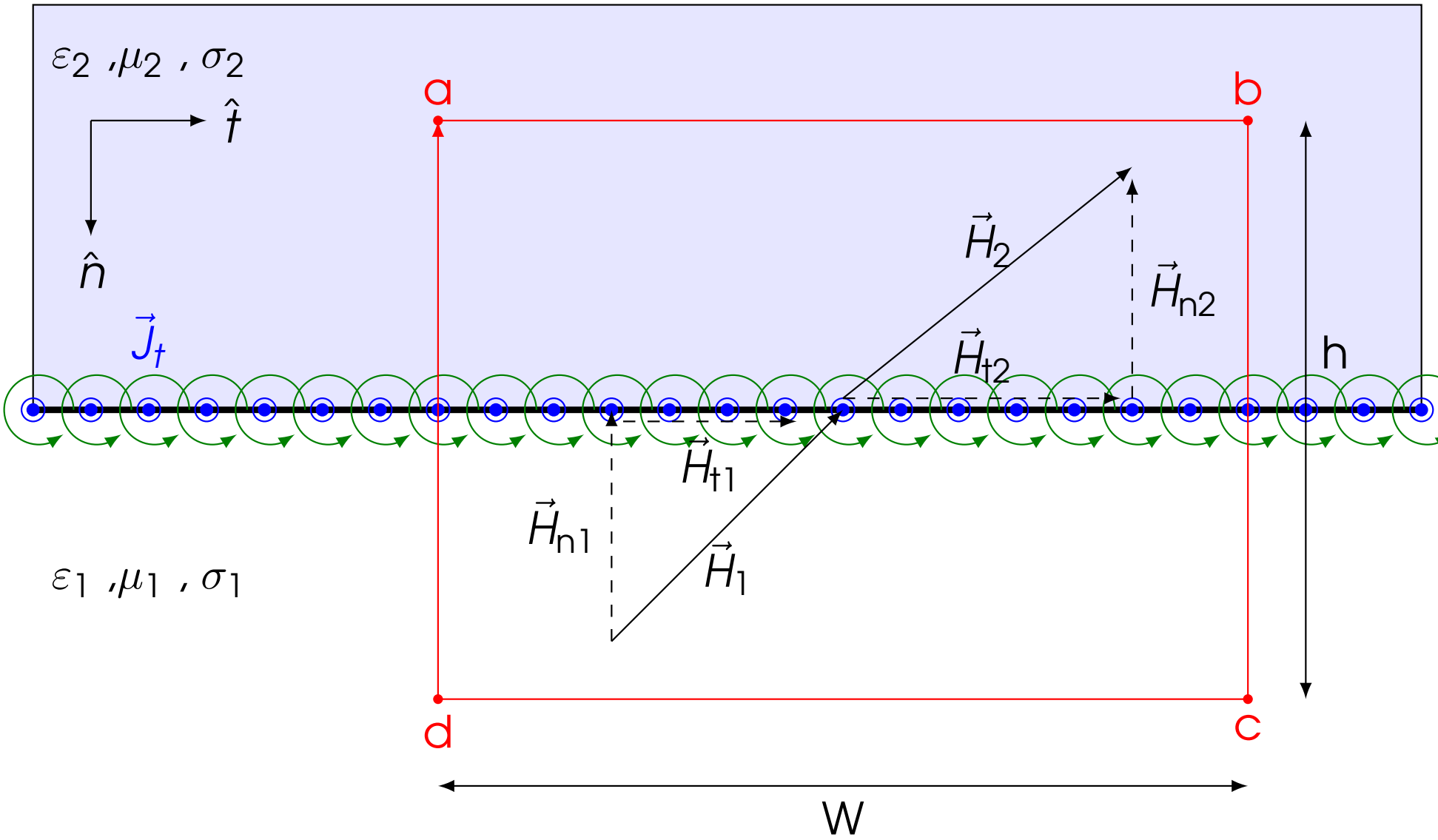
7.1 I can use the Biot-Savart law to simple magnetostatic systems to find the magnetic field at an observation point.

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.

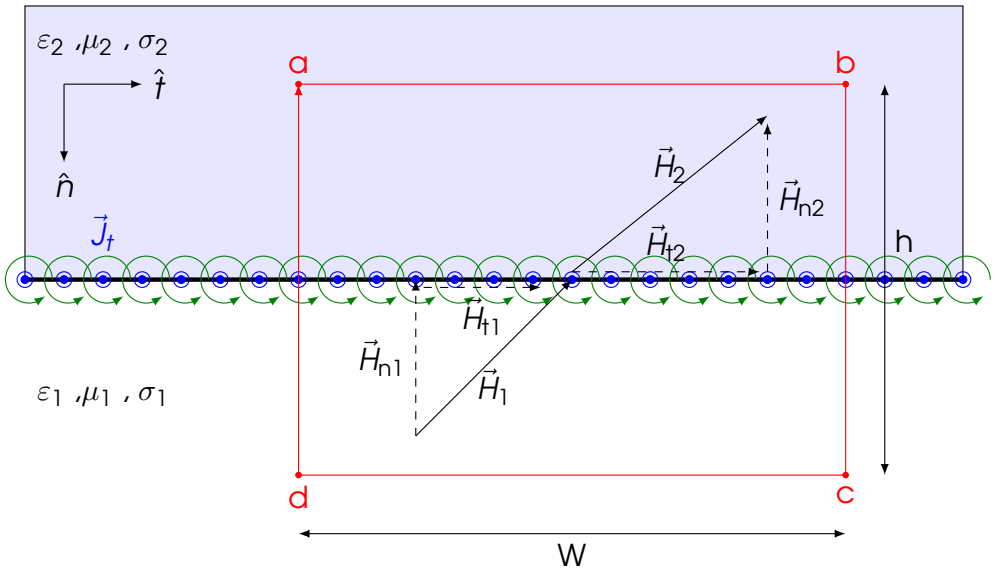
7.4 I can apply the magnetic field boundary conditions to calculate magnetic fields on both sides of a material boundary.

Magnetic Boundary Conditions



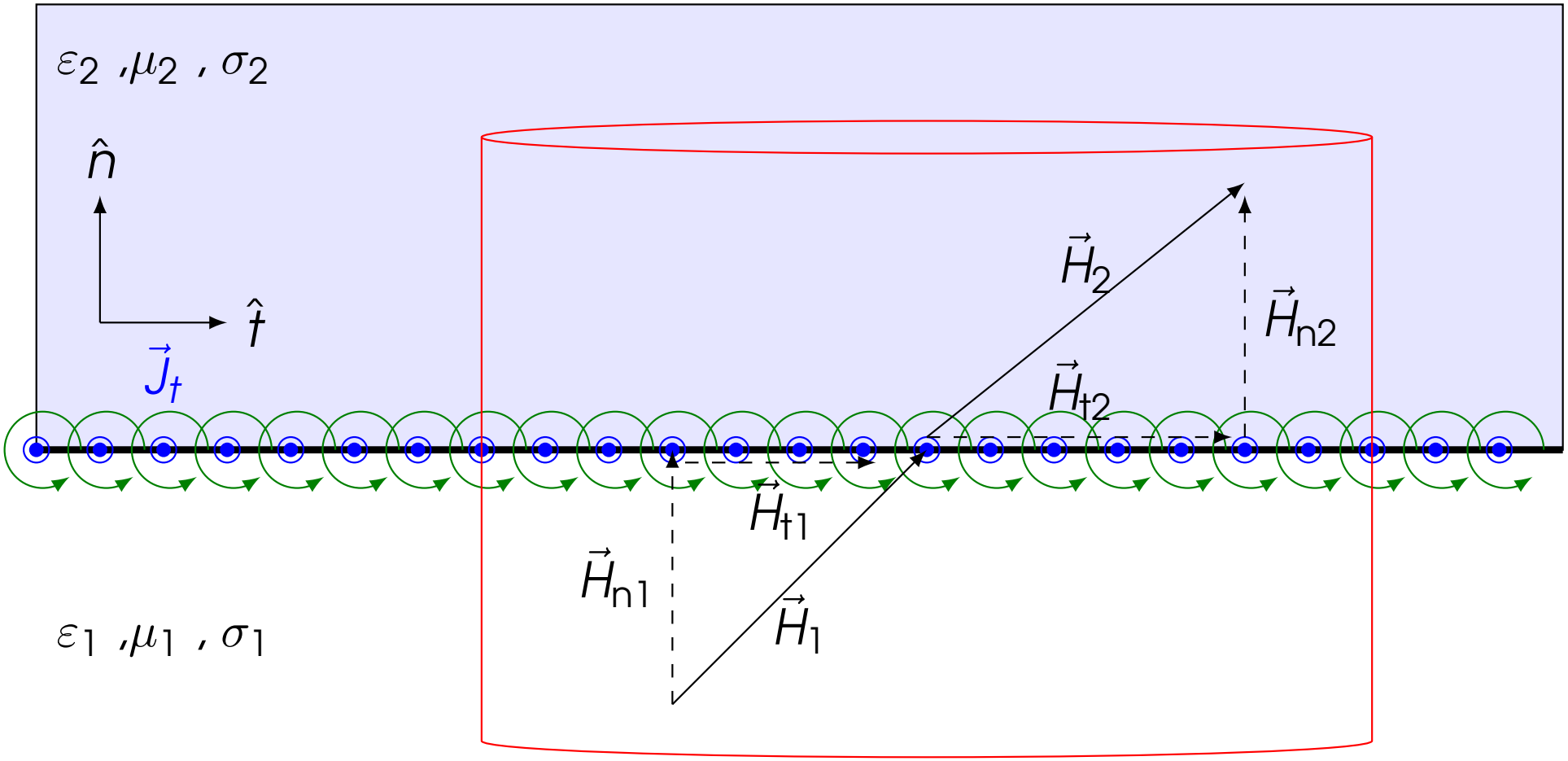
$\vec{H}$ Boundary Conditions: Transverse

We can write:

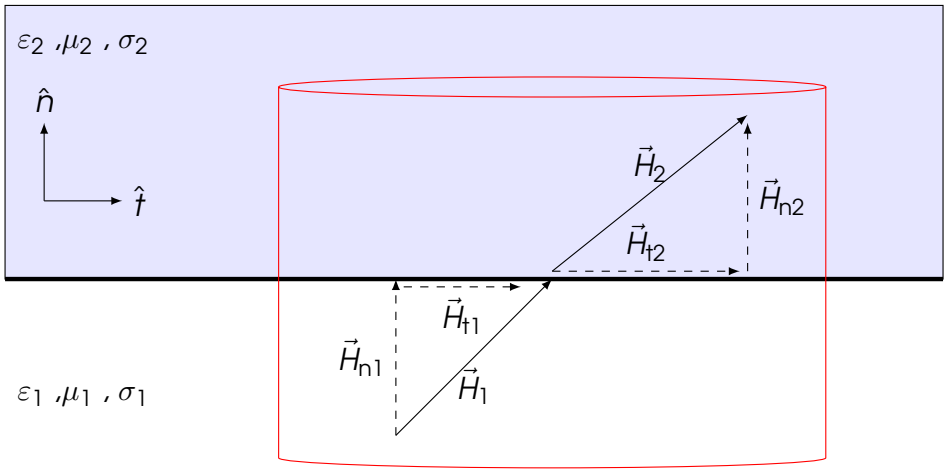


Using Ampere's Law for magnetism:

$\vec{H}$ Boundary Conditions: Normal



$\vec{H}$ Boundary Conditions: Normal

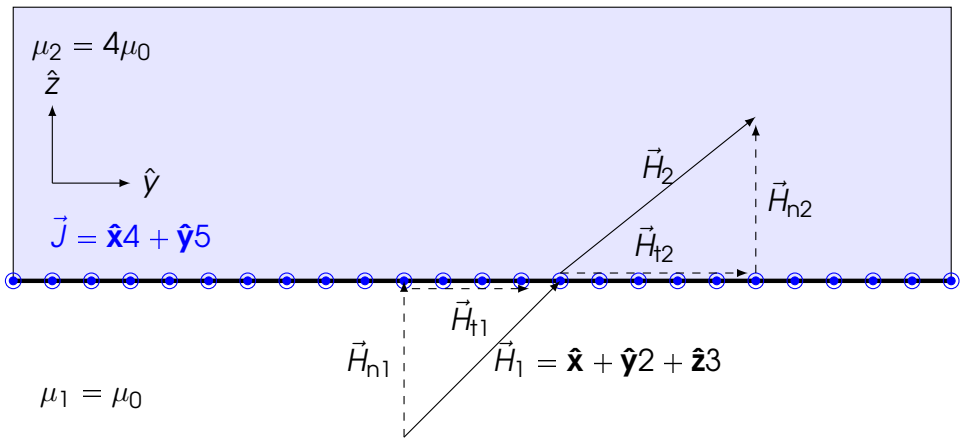


$\vec{H}$ Boundary Condition Summary

	Electric	**Magnetic**
Normal	$\hat{n}_{21} \cdot \left(\varepsilon_1 \vec{E}_1 - \varepsilon_2 \vec{E}_2 \right) = \rho_s$	$\mu_2 \vec{H}_{n2} = \mu_1 \vec{H}_{n1}$
Transverse	$\vec{E}_{t1} = \vec{E}_{t2}$	$\hat{n}_{21} \times \left(\vec{H}_1 - \vec{H}_2 \right) = \vec{J}$

Boundary Condition: Example

A magnetic field $\vec{H} = \hat{\mathbf{x}} + \hat{\mathbf{y}}2 + \hat{\mathbf{z}}3$ exists in a material with $\mu = \mu_0$ and is incident on a boundary with a surface current of $\vec{J} = \hat{\mathbf{x}}4 + \hat{\mathbf{y}}5$. The material on the other side of the boundary has $\mu = 4\mu_0$. Determine $\vec{H}_2$.



1. Draw a picture
2. Identify T & N

   $\vec{H}_{t1} =$

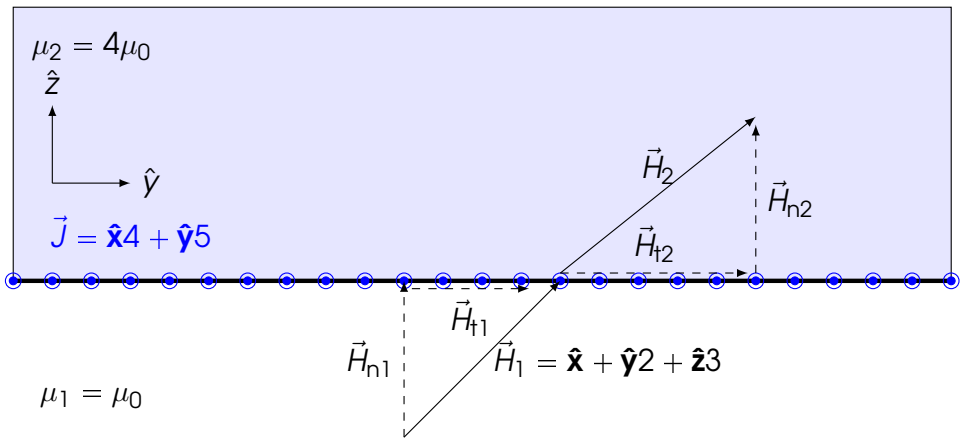
   $\vec{H}_{n1} =$
3. $\hat{n}_{2,1} =$
4. Normal BC

$\Longrightarrow H_{2y} =$

$\Longrightarrow H_{2x} =$

Boundary Condition: Example

A magnetic field $\vec{H} = \hat{\mathbf{x}} + \hat{\mathbf{y}}2 + \hat{\mathbf{z}}3$ exists in a material with $\mu = \mu_0$ and is incident on a boundary with a surface current of $\vec{J} = \hat{\mathbf{x}}4 + \hat{\mathbf{y}}5$. The material on the other side of the boundary has $\mu = 4\mu_0$. Determine $\vec{H}_2$.



(5) Normal BC

(6) Put it all together

$\vec{H}_2 =$