ECEN 322

Summary of Coordinate Transformations

Cartesian	Cylindrical
Cylindrical	Cartesian
Cartesian	Spherical
Spherical	Cartesian

Divergence Theorum and Curl

Gradient - Scalar Field

Divergence - Vector Field

If $\nabla \cdot \vec{A} = 0$ then $\vec{A} =$ solenoidal vector fied (whatever goes in comes out)

for Circulation *** Δ is underlined in Nguyen's notation. Look into this.

Divergence Theorum	$\int\limits_V \nabla \vec{A} \cdot dV = \oint\limits_S \vec{A} d\vec{S}$
Circulation of $\vec{A}$ around countour C	$\Delta \oint\limits_C \vec{A} d\vec{l}$
Curl	$\nabla \times \vec{A} = \frac{1}{\Delta s} \lim_{\Delta s \to \emptyset} \oint\limits_S \vec{A} d\vec{l}$
Stoke's Theorum	$\int\limits_S \nabla \times \vec{A} \cdot d\vec{s} = \oint\limits_C \vec{A} \cdot d\vec{l}$
Two Null Identitites	$\nabla \times (\nabla V) \equiv 0$
	$\nabla \cdot (\nabla \vec{A}) \equiv 0$

Maxwell's Equations

$\vec{E}(x, y, z, t), \vec{H}, \vec{D}, \vec{B}, \vec{J}, \varphi_v$

Can be in differential or integral form - Differential form is most generally used

$\int\limits_S \vec{J} \cdot d\vec{S} = I \leftarrow$ total current flow thru open surface

Contributor	Differential Form (Point Form)	Integral Form (Large Scale Form)
Faraday	$\nabla \times \vec{E} = \frac{-\delta \vec{B}}{\delta t}$	$\oint\limits_C \vec{E} \cdot d\vec{l} = \frac{-\delta \vec{B}}{\delta t} \cdot d\vec{S}$
Ampere	$\nabla \times \vec{H} = \vec{J} + \frac{-\delta \vec{D}}{\delta t}$	$\int\limits_S \vec{J} \cdot d\vec{S} + \int\limits_S \frac{d\vec{D}}{dt} \cdot d\vec{S}$
Gauss	$\nabla \cdot \vec{D} = \varphi_v$	$\oint\limits_C \vec{D} \cdot d\vec{s} = Q$
No Magnetic Charges	$\nabla \cdot \vec{B} = 0$	$\oint\limits_C \vec{B} \cdot d\vec{s} = 0$
Modified Ampere's Law	$\frac{\delta \vec{D}}{\delta t}$	

When a field is static, $\frac{d}{dt} = 0$

Special Cases of Maxwell's Equations: Static $\vec{E}$ and $\vec{H}$

$\vec{E}, \vec{H} = f(x, y, z) \neq f(t) \rightarrow \frac{\delta}{\delta t} =$

Faraday	$\nabla \times \vec{E} = 0$	$\oint_C \vec{E} \cdot \vec{dl} = 0$
Ampere	$\nabla \times \vec{H} = \vec{J}$	$\oint_C \vec{H} \cdot \vec{dl} = I$
Gaus	$\nabla \cdot \vec{D} = \varphi_v$	$\oint_C \vec{D} \cdot \vec{ds} = Q$
Magnetic Charge	$\nabla \cdot \vec{B} = 0$	$\oint_C \vec{B} \cdot \vec{ds} = 0$

$\vec{E} = -\nabla V$

Poisson	$\nabla^2 V = \frac{\varphi_v}{\epsilon}$
LaPlace	$\nabla^2 V = 0$

Charge Conservation $\quad \nabla \cdot \vec{J} = -\frac{d\varphi_v}{dt}$, v - some arbitrary volume

Special Cases of Maxwell's Equations: Source-Free Regions ($\varphi = 0, J = 0$)

Faraday	$\nabla \times \vec{E} = \frac{d\vec{B}}{dt}$
Ampere	$\nabla \times \vec{H} = \frac{d\vec{D}}{dt}$
Gaus	$\nabla \cdot \vec{D} = 0$
No Magnetic Charges	$\nabla \cdot \vec{B} = 0$