UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

DATE | STUDENT NO. | PG.
FULL NAME
ASSIGNMENT | COURSE

Divergence Theorem

$$\underbrace{\oiint_{S=\partial V} \vec{F}\cdot d\vec{A}}_{\text{flux}} = \iiint_V (\nabla\cdot\vec{F})\,dV$$

Stokes Theorem

$$\underbrace{\oint_{C=\partial S} \vec{F}\cdot d\vec{l}}_{\text{flow or circulation}} = \iint_S (\nabla\times\vec{F})\cdot d\vec{A}$$

1) $\oiint_S \vec{D}\cdot d\vec{s} = \iiint_V (\nabla\cdot\vec{D})\,dV = \iiint_V \rho_v\,dV = Q_{enc}$ Gauss Law

$\nabla\cdot\vec{D} = \rho_v$

2) $V_{emf} = \mathcal{E}_{emf} = \oint_C \vec{E}\cdot d\vec{l} = \iint_S (\nabla\times\vec{E})\cdot d\vec{s} = \iint_S -\frac{\partial}{\partial t}\vec{B}\cdot d\vec{A}$ Faraday Law

Lenz's Law

$\nabla\times\vec{E} = -\frac{\partial}{\partial t}\vec{B}$

3) $\oint_C \vec{H}\cdot d\vec{l} = \iint_S (\nabla\times\vec{H})\cdot d\vec{s} = \iint_S (\vec{J} + \frac{\partial}{\partial t}\vec{D})\cdot d\vec{s} = \iint_S \vec{J}\cdot d\vec{A} + \iint_S \frac{\partial}{\partial t}\vec{D}\cdot d\vec{A}$

Ampere – Maxwell Law $\quad \nabla\times\vec{H} = \vec{J} + \frac{\partial}{\partial t}\vec{D} \quad = I_{conduction} + I_{displacement}$

4) $\oiint_S \vec{B}\cdot d\vec{A} = \iiint_V (\nabla\cdot\vec{B})\,dV = 0 \qquad \nabla\cdot\vec{B} = 0$ Gauss Law for magnetic fields

$$\boxed{\begin{array}{ll} \nabla\cdot\vec{D} = \rho_v & \nabla\times\vec{E} = -\frac{\partial}{\partial t}\vec{B} \\ \nabla\cdot\vec{B} = 0 & \nabla\times\vec{H} = \vec{J} + \frac{\partial}{\partial t}\vec{D} \end{array}}$$

time varying fields mean $\vec{E}$ and $\vec{H}$ are "coupled"