Calculus 2 For Engineers

Class: APPM 1360 ©Maximilien Notz 2025

Charges and Fields

Coulomb's Law	$F = k\frac{q_1 q_2}{r^2}$
Definition of electric	$\vec{E} = \frac{\vec{F}_{onq}}{q}$
E-field (point charge)	$\vec{E} = k\frac{Q}{r^2}\hat{r}$
E-field (many charges)	$\vec{E}_{tot} = \sum \vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 + ...$
E-field (integral)	$\vec{E}_{tot} = \int d\vec{E}, d\vec{E} = k\frac{dQ}{r^2}$
Densitys	$dQ = \lambda\, dx = \sigma\, dA = \rho\, dV$

Gauss's Law

Electric flux	$\Phi = \vec{E} \cdot \vec{A} = \int \vec{E} \cdot d\vec{a}$
Gauss Law	$\oiint \vec{E} \cdot d\vec{a}$

Electro-Dynamic

Voltage	$v = \frac{\Delta U}{q}$
	$\Delta U = W_{ext} = -W_{field}$
	$\Delta U = q\Delta V$
	$\Delta V = -\vec{E} \cdot \Delta\vec{r}$
	$W_{ext} = \Delta U = q\Delta V$
electric current	$I = \frac{dq}{dt}$
Current Density	$J = \frac{I}{A} = n_e e v_{drift}$
Ohm's law	$J = \sigma E$

Ciruit

Capacitance	$C = \frac{Q}{V} = \frac{\epsilon_0 A}{d}$
	$U = \frac{1}{2}QV$
Electric Current	$I = \frac{dQ}{dt}$
Circuits	$V = IR$
	$R = \frac{\rho L}{A}$
	$J = nqV_{drift} = \frac{I}{A}$
	$P = IV = I^2 R = \frac{V^2}{R}$

Magnetism

Definition of **B**	$F_{on\ q} = q\vec{v} \times \vec{B}$
Bio-Savart Law	$d\vec{B} = \frac{\mu_0 I}{4\pi}\frac{d\vec{l} \times \hat{r}}{r^2}$
Force by a wire	$\vec{F} = I\vec{L} \times \vec{B}$
ma Total force	$\vec{F}_{tot} = \vec{F}_B + \vec{F}_E$
Ampere's Law	$\oint \vec{B} \cdot d\vec{a} = 0$
Ampere's Law	$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{enclosed}$
Faraday's Law	$\mathcal{E} = \oint \frac{\vec{f}_{on\ q}}{q} \cdot d\vec{l} = \oint \vec{E} \cdot d\vec{l}$
	$\mathcal{E}_{N\ loop} = -N\frac{d\Phi_B}{dt}$