KOORDINATSYSTEMER

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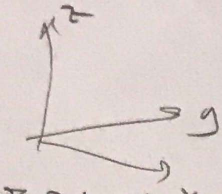
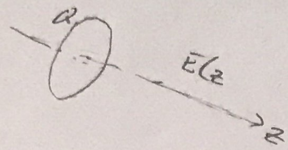
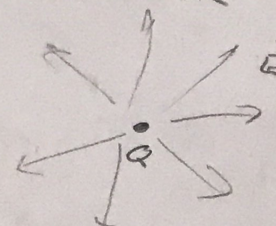
KARTESISK



SYLINDRISK



SFÆRISK



INTEGRALER

Linje $\int_L \vec{A} \cdot d\vec{l}$ $\oint_C \vec{A} \cdot d\vec{l}$ | Flate $\int_S \vec{A} \cdot d\vec{s}$ $\oint_S \vec{A} \cdot d\vec{s}$ | Volum $\int_V g \, dv$

SKALARE FUNKSJONER

høyde: $h(x,y)$

temperatur: $T(x,y,z)$

$T(x,y,z,t)$

trykk: $P(x,y,z,t)$

Elektrisk potensial: $V(x,y,z)$

Ladningstetthet: $g(x,y,z)$

VEKTORFELT

elektrisk felt $\vec{E}(x,y,z \ldots t)$

magnetisk felt $\vec{B}(x,y,z)$

strøm $\vec{J}(x,y,z)$

[vann, elektrisk] $\vec{I}(x,y,z)$

- Beskrive
- Integrere / derivere dem
- "Noen morsomme sammenhenger mellom disse integralene og derivertene"

nyttige

GRADIENTEN

$$\nabla V = \left[\frac{\partial V}{\partial x}, \frac{\partial V}{\partial y}, \frac{\partial V}{\partial z} \right] \text{ Vektor}$$

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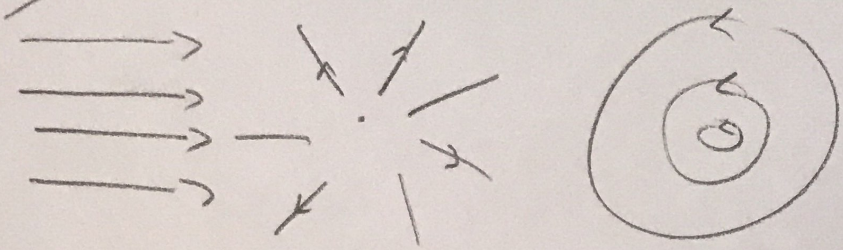
NABLAOPERATOREN: $\nabla = \left[\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z} \right]$ VEKTOR

LAPLACEOPERATOREN: $\nabla^2 = \nabla \cdot \nabla = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$ SKALAR

$$\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$$

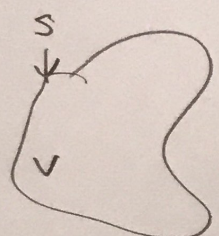
VEKTORFELT - Karakteristikker:



DIVERGENS:

$$\text{div}\,\vec{A} = \lim_{\Delta v \to 0} \frac{\oint \vec{A} \cdot d\vec{S}}{\Delta v} = \nabla \cdot \vec{A}$$ skalar

DIVERGENSTEOREMET:

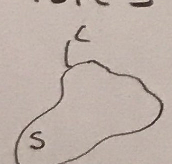


$$\oint_S \vec{A} \cdot d\vec{S} = \int_V \nabla \cdot \vec{A} \, dv$$

SIRKULASJON (CURL):

$$\text{curl}\,\vec{A} = \lim_{\Delta S \to 0} \frac{\oint \vec{A} \cdot d\vec{l}}{\Delta S} = \nabla \times \vec{A}$$ vektor

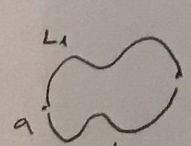
STOKES TEOREM:



$$\oint_C \vec{A} \cdot d\vec{l} = \int_S \nabla \times \vec{A} \cdot d\vec{S}$$

KONSERVATIVE FELT

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



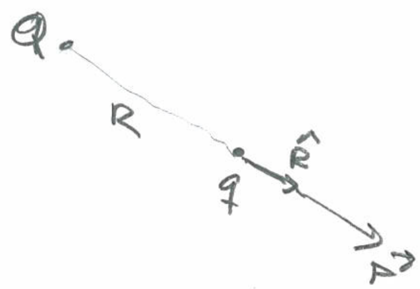
$$\int_{a, L_1}^{b} \vec{A} \cdot d\vec{l} = \int_{a, L_2}^{b} \vec{A} \cdot d\vec{l}$$

SISTE MORSOMME OPERATORRELASJON:

$$\nabla^2 \vec{A} = \nabla(\nabla \cdot \vec{A}) - \nabla \times (\nabla \times \vec{A})$$

ELEKTROSTATIKK

Coulombs lov



$$\vec{F} = \frac{1}{4\pi\varepsilon_0}\,\frac{Qq}{R^2}\,\hat{R}$$

ε_0 : Elektrisk permitivitet i vakum

$$\varepsilon_0 = 8.85\cdot10^{-12}\ \frac{C^2}{Nm^2}$$

Lading til et elektron q_e / proton : q_P

$$q_p = -q_e = 1{,}6\cdot10^{-19}\,C$$

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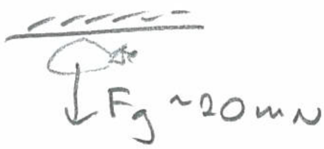
STØRRELSE



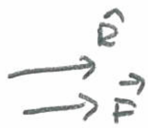
$R = 10^{-13}\,m \Rightarrow |F_{ep}| \sim 20\,mN$

RETNING

$$\hat{R} = \frac{\vec{R}}{R}$$

Like ladinger:

$\vec{F} \propto |Qq|\,\hat{R}$



Ulike ladinger

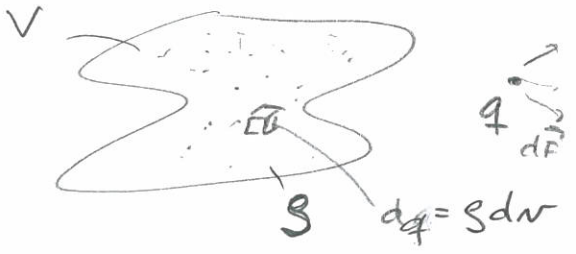
$\vec{F} \propto -|Qq|\,\hat{R}$

SUPERPOSISJON (Kraft fra FLERE punktladinger)

$$\vec{F} = \sum_i \vec{F}_i = \frac{q}{4\pi\varepsilon_0}\sum_{i=1}^{n}\frac{Q_i}{R_i^2}\,\hat{R}_i$$

Regneeksempel 2.1 $\leftrightarrow$ typiske ladinger: batteri...

Coulombs lov for et utstrakt legeme



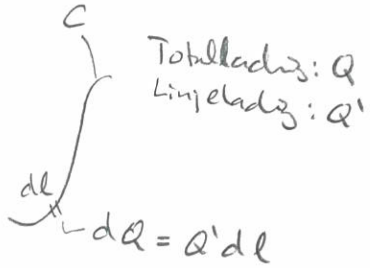
$$\vec{F} = \frac{q}{4\pi\varepsilon_0} \int_V \frac{\rho\, dv}{R^2} \hat{R}$$

ELEKTRISK FELT

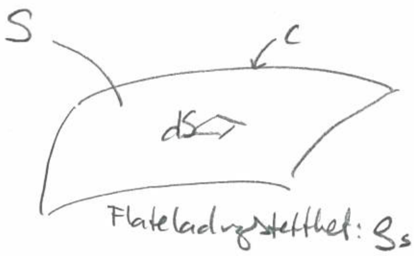
$$\boxed{\vec{E} = \lim_{q \to 0} \frac{\vec{F}}{q}}$$

For punktladning Q: $\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{Q}{R^2} \hat{R}$

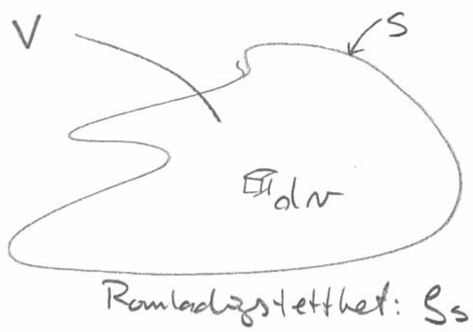
SUPERPOSISJON GJELDER OGSÅ FOR E-FELT



$$\Rightarrow \quad \vec{E} = \frac{1}{4\pi\varepsilon_0} \int_C \frac{Q' \hat{R}}{R^2} dl$$



$$\Rightarrow \quad \vec{E} = \frac{1}{4\pi\varepsilon_0} \int_S \frac{\rho_s \hat{R}}{R^2} dS$$



$$\Rightarrow \quad \vec{E} = \frac{1}{4\pi\varepsilon_0} \int_V \frac{\rho \hat{R}}{R^2} dv$$

PRAKTISKE REGNEOVERSLAG

→ Let etter symmetrier
(prøv å forstå feltet kvalitativt)

→ Velg et hensiktsmessig koordinatsystem

→ Sjekk dimensjoner og oppførsel f.eks i symmetripunkter / symmetriplan og/eller langt unna

16/1-2018