Maxwell's equations (differential form)

$$\begin{aligned}
\mathbf{curl}\,\boldsymbol{E} &= -\frac{\partial \boldsymbol{B}}{\partial t} && \text{Faraday's law}\\
\mathbf{curl}\,\boldsymbol{H} &= \boldsymbol{J} + \frac{\partial \boldsymbol{D}}{\partial t} && \text{Ampère's law}\\
\operatorname{div}\boldsymbol{D} &= \rho && \text{electric Gauss law}\\
\operatorname{div}\boldsymbol{B} &= 0 && \text{magnetic Gauss law}
\end{aligned}$$

Material laws

$$\begin{aligned}
\boldsymbol{B} &= \mu\boldsymbol{H} + \boldsymbol{M}\\
\boldsymbol{D} &= \varepsilon\boldsymbol{E} + \boldsymbol{P}\\
\boldsymbol{J} &= \sigma(\boldsymbol{E} + \boldsymbol{v}\times\boldsymbol{B}) && \text{Ohm's law}
\end{aligned}$$

simplifications in the lecture:

- $\boldsymbol{M} = \boldsymbol{P} = \boldsymbol{v} = 0$
- μ, ε, σ scalar and only depending on $\boldsymbol{x}$ (linear material laws)

Field quanities and units

quantity	*SI unit*	*description*
$\boldsymbol{B}$	$\mathrm{Vs/m^2 = T}$	magnetic flux density (magnetic induction)
$\boldsymbol{D}$	$\mathrm{As/m^2}$	electric flux density (displacement current density)
$\boldsymbol{E}$	$\mathrm{V/m}$	electric field intensity
$\boldsymbol{H}$	$\mathrm{A/m}$	magnetic field intensity
$\boldsymbol{J}$	$\mathrm{A/m^2}$	electric current density
$\boldsymbol{J}_{\mathrm{tot}}$	$\mathrm{A/m^2}$	total current density
$\boldsymbol{M}$	$\mathrm{Vs/m^2 = T}$	magnetizagion (remanent flux density)
$\boldsymbol{P}$	$\mathrm{As/m^2}$	polarization
$\boldsymbol{v}$	$\mathrm{m/s}$	velocity
ε	$\mathrm{As/Vm}$	electric permittivity
μ	$\mathrm{Vs/Am = H/m}$	magnetic permeability
ρ	$\mathrm{As/m^3}$	charge density
σ	$\mathrm{A/Vm = 1/\Omega m}$	electric conductivity

units: ampere A, henry H, meter m, tesla T, volt V, ohm Ω, seconds s