Electromagnetic Induction

Motional EMF (straight wire):
$V = v \cdot B \cdot \ell$

Constant field:
$V_i(t) = -n \cdot \dot{A}(t) \cdot B$

Generator voltage:
$V_G(t) = n \cdot A \cdot B \cdot \omega \cdot \sin(\omega \cdot t)$

Constant area:
$V_i(t) = -n \cdot A \cdot \dot{B}(t)$

Magnetic field of a current:
e.g. solenoid
$B(t) = \mu \cdot \dfrac{n \cdot I}{\ell}$

Lenz's Law:

*The direction of the induced current is such that it will try to **oppose** the change in flux that is producing it.*

Faraday's Law:
EMF induced in a loop of wire (n turns)

$V_i(t) = -n \cdot \dot{\Phi}(t)$

Magnetic flux:
$\Phi(t) = A(t) \cdot B(t)$

Self-inductance of a coil:
$V_s(t) = -L \cdot \dot{I}(t)$

Inductance of a solenoid:
$L = \mu \cdot \dfrac{n^2 \cdot A}{\ell}$

Breaking current:
$I(t) = I_0 \cdot e^{-t/\tau}$

Making current:
$I(t) = I_0 \cdot (1 - e^{-t/\tau})$

Time constant:
$\tau = \dfrac{L}{R}$

Half life:
$T_{1/2} = \tau \cdot \ln 2 = \dfrac{L}{R} \cdot \ln 2$

Magnetic energy stored in a coil:
$W_m = \dfrac{1}{2} \cdot L \cdot I^2$

Energy density in the magnetic field:
$w_m = \dfrac{1}{2 \cdot \mu} \cdot B^2$