JOINT INSTITUTE
交大密西根学院

Final Review

Part I (Figures)

Teaching Assistant
Xie Jinglei

1

Maxwell's Equations

Maxwell's Equations

Gauss's law for $\vec{E}$:

$$\underbrace{\oint \vec{E} \cdot d\vec{A}}_{\text{Flux of electric field through a closed surface}} = \frac{Q_{\text{encl}}}{\epsilon_0} \tag{29.18}$$

Flux of electric field through a closed surface

Q_{encl}: Charge enclosed by surface

ϵ_0: Electric constant

Gauss's law for $\vec{B}$:

$$\oint \vec{B} \cdot d\vec{A} = 0 \tag{29.19}$$

Flux of magnetic field through any closed surface ... equals zero.

Faraday's law for a stationary integration path:

$$\oint \vec{E} \cdot d\vec{l} = -\frac{d\Phi_B}{dt} \tag{29.20}$$

Line integral of electric field around path

Negative of the time rate of change of magnetic flux through path

Maxwell's Equations

Ampere's law for a stationary integration path:

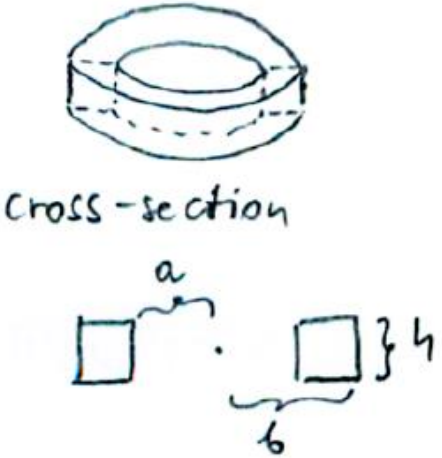
$$\overbrace{\oint \vec{B}\cdot d\vec{l}}^{\text{Line integral of magnetic field around path}} = \underbrace{\mu_0}_{\text{Magnetic constant}}\Big(\underbrace{i_C}_{\text{Conduction current through path}} + \underbrace{\overbrace{\epsilon_0}^{\text{Electric constant}}\overbrace{\frac{d\Phi_E}{dt}}^{\text{Time rate of change of electric flux through path}}}_{\text{Displacement current through path}}\Big)_{\text{encl}} \tag{29.21}$$

2

Inductance

Toroidal solenoid

Example (inductance of a toroidal coil with rectangular cross-section)



Magnetic field inside $\boxed{B = \dfrac{\mu_0 I N}{2\pi r}}$ (see rec. class)

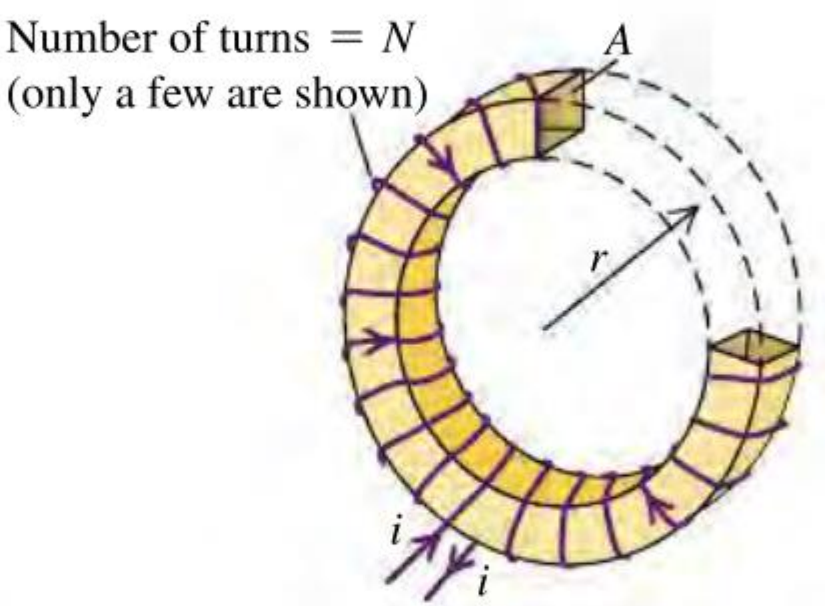
Flux through a single turn

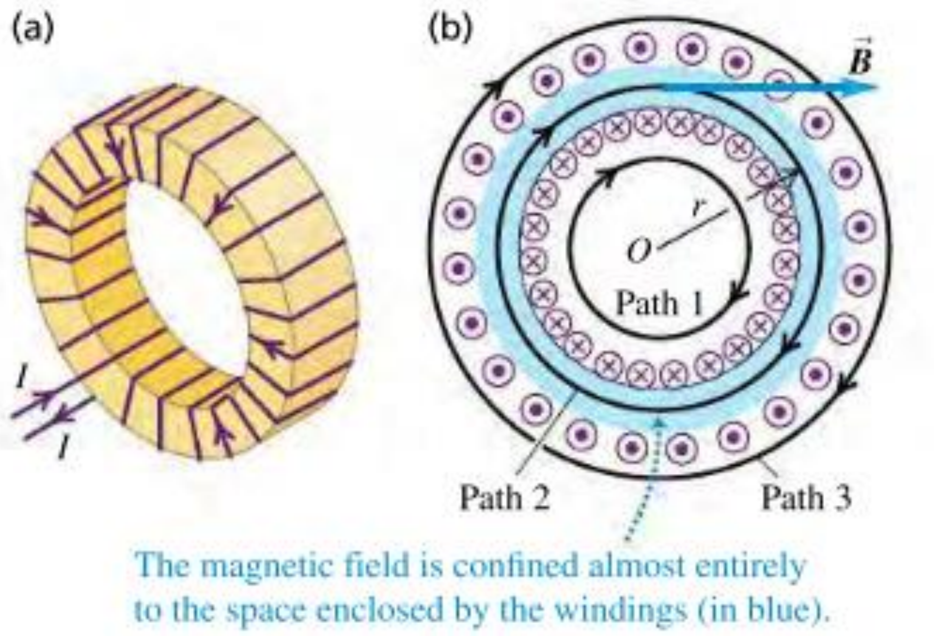
$$\Phi_B^{(1)} = \int \bar{B} \cdot d\bar{S} = \frac{\mu_0 I N}{2\pi} h \int_a^b \frac{dr}{r} = \frac{\mu_0 I N h}{2\pi} \ln\left(\frac{b}{a}\right)$$

Total flux

$$\Phi_B = \underset{\text{\# of turns}}{N} \cdot \Phi_B^{(1)} = \underbrace{\frac{\mu_0 N^2 h}{2\pi} \ln\left(\frac{b}{a}\right)}_{L} I \; ; \qquad \boxed{L = \frac{\mu_0 N^2 h}{2\pi} \ln\left(\frac{b}{a}\right)}$$

Toroidal solenoid

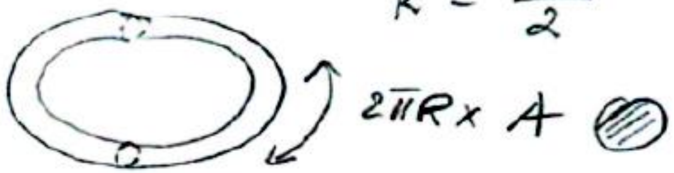




Toroidal solenoid

Example. Energy stored in a toroidal solenoid. (Assume $b-a \ll a$)

$R = \frac{a+b}{2}$



$$L = \frac{\mu_0 N^2 A}{2\pi R}$$

$$u = \frac{1}{2} L I^2 = \frac{1}{2} \frac{\mu_0 N^2 A}{2\pi R} I^2$$

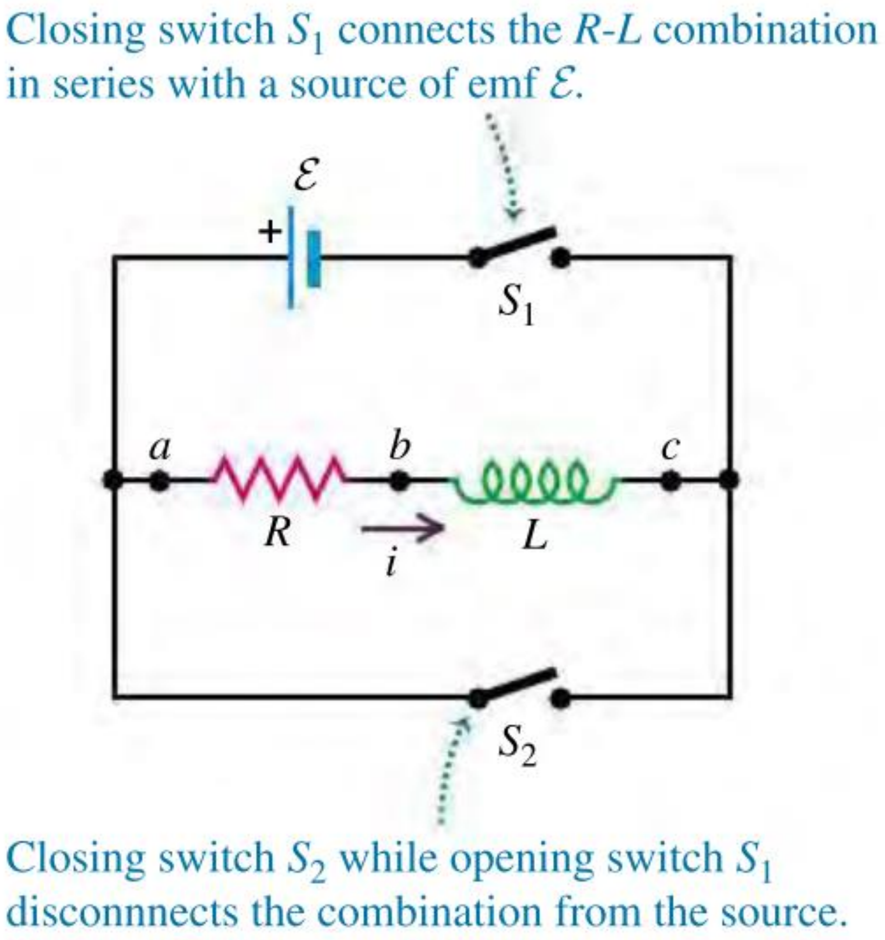
$A = (b-a) \cdot h$

Volume of the torroidal coil: $V = 2\pi R A$.

3

RL circuits

RL circuits

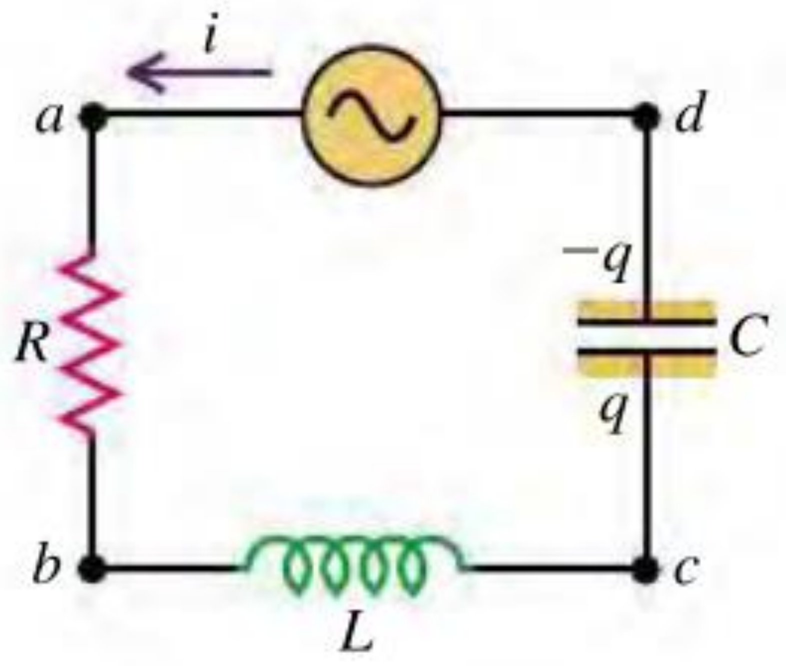


Closing switch S_1 connects the R-L combination in series with a source of emf $\mathcal{E}$.
$\mathcal{E}$
+
S_1
a
b
c
R
i
L
S_2
Closing switch S_2 while opening switch S_1 disconnects the combination from the source.

4

RLC circuits and AC circuits

RLC & AC circuits



Good luck for your final exam!