phi\_{B} = int b\*ds = int Bdscostheta

phi\_{B} is the magnetic flux

SI unit = `Tm^2` = Wb(weber)

Gausss law: the total magnetic flux through a closed surface is zero

oint B\*ds = 0

Faradays law

The induced emf in a closed loop equals the negative of the time rate of change of magnetic flu through theloop

e = (-dphi\_{B}/(dt)

for N loops e = (-Ndphi\_{B})/(dt)

induced emf is produced only when there change in magnetic flux through loop phi =Bscostheta

(dq) = (-dphi)/ R

I and e depend on deltat, deltaq do not depend on deltat

Lenzs law

The direction of any magnetic induction effect is such that it oppose the cause of the effect

&image&

Dot means outward(away from plane of praper) and cross means inward(into the papper) (like the arrow goes outward with dot and cross is the backside)

Motional electromotive force

A rectangular conductor moving with a v speed in a cross(inward) magnertic field

x x x x x x x x x x x x x x x x x x x x v x x x x x x x x x

Fe

++\_\_

l

Fm

F\_{m} = -e( v xx B)

Under influence of this force elecrons move to lower end of conductor and positive charge at upper end causing electric field

F\_{e} = eE

These two forces are in opposite direction

F\_{e} = F\_{m}

eE = eBv

E = Bv

Delta V = El delta V = Blv

&image&

x x x x x x x x x x x x x x x x x x x x x x x x x x x x

F

Fm

a

R

v

b

V\_{a} >V\_{b} socurrent anticlockwise(find using fleming right hand)

i = e/R = (Blv)/R

F\_{m} = ilb = (B^2l^2v)/R

Power(energy dissipiated) = w/t = Fv = (B^2l^2v^2)/R

Motional emf same as faradays

abs(e) = abs((-dphi\_{B})/(dt)) = (dBs)/(dt) = (dBlx)/(dt) = BL(dx)/(dt) = Blv

integrating mathed

for small dl

e = int\_b^a (v xx B)\*dl

motional emf of rotating bar

x x x x x x x x x x x x x x x x x x

p

r

l

O

dr

v

Pivoted at O

e = int\_0^l Bvdv

= int\_0^l Br omegadr = (Bomegal^2)/2

e = (Bomegal^2)/2

self inductance (L)

source of self induced emf is change in thecurrent in same crcuit

as per lenzs law self induced emf opposes the change in current that caused the emf so that it makes it more difficult for variation in current to occur

L = (Nphi\_{B})/i

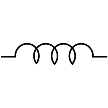
L = abs((-e)/(di)/(dt))

Unit is henry

Purpose of an inductor is to prevent varaiations and provide a steady current

Potential difference across an inductor

&Image&



b

a

When current constant no change, `V\_{ab}` = 0, no self induced emf

When current increasing (that’s a connected to +ve terminal and b to –ve) inductor acts like a cell connected oppositly to reduce the current,

(di)/(dt) >0 v\_{ab} >0

When current is decvreasing(a to –ve and bto +ve) inductor acts like a cell onnected in same direction (+ve to b and –ve to a) to increase current

(di)/(dt) < 0 v\_{ab} < 0

V\_{ab} = -e = L(di)/(dt)

(resistance oppose currentsimilarly inductor oppose `(di)/(dt)` )

Kirchoffs law

Just add `L(di)/(dt)` if there is a inductor looking at direction choose +/-

Inductance in a solenoid

B = mu\_{0}ni = mu\_{0}N/li

N = turns l = length s = cross sectional area

Phi\_{B} = Bs = mu\_{0} (Ns)/li

L = (Nphi\_{B})/i

L = (mu\_{0}N^2s)/l

Energy

Energy in a capactiro is stored in electric filed between the plates similarly in inductor cnergy is stored in its magnetic field

P = (-dU)/(dt) = (dW)/(dt) = -ei = -Li(di)/(dt)

U = L int\_0^I idi

U = 1/2Li^2

U is the energy stored in magnetic field of inductror

When current becomes steady (di)/(dt) = 0 no more energy taken by inductor

`i rightarrow 0` inductor acts as sourve supplying energy 1/2Li^2 to the circuit.

(if we interrupt the circuit suddenly by opening switch the currnet decreases rapidly induced emf is large and enrgy dissipiated as a spark across switch)

Resistor: as current flow energy flow and dissipiate as heat

Inductor: energy flow to ideal inductor(0 resistenace) only when current increase and this energy is released when current decreases

Mu = 1/2B^2/mu\_{0}

Mu is the magnetic energy density

Mu = U/text(Volume)text( )B = mu\_{0}ni

In electrostatics mu = 1/2epsilon\_{0}E^2

Mutual inductance

Change incurrent in onecircuit induce a current in second circuit

i\_{1} through coil 1 definintion

&image&

2

1

i1

Definition 1

`N\_{2}phi\_{B\_{2}} propto i\_{1}`

`N\_{2}phi\_{B\_{2}} = Mi\_{1}`

M = (N\_{2}phi\_{B\_{2}})/i\_{1}

M is the mutual inductance

D3efenition 2

(di)/(dt) propto e\_{2}

`(di)/(dt)` rate of change of current in circuit, aand an induced emf `e\_{2}` in circuit 1

M = abs((-e\_{2})/((di)/(dt)))

Negative means in direetion opposite to any change in current in circuit 1

M depends upon closness of two circuits, their orientation and size and turns

M\_{12} = (N\_{2}phi\_{B\_{2}})/i\_{1}

M\_{21} = (N\_{1}phi\_{B\_{1}})/i\_{2}

M = M\_{12} = M\_{21} = -e\_{2})/((di\_{1})/(dt)) =-e\_{1})/((di\_{2})/(dt))

Mutual induction of a solenoid surrounded by a coil

M = (mu\_{0}N\_{1}N\_{2}piR\_{1}^2)/l\_{1}

`N\_{1},R\_{1},l\_{1}`(length) are the values of solenoid

`N\_{2},R\_{2}` are the value of the coil surrounding the solenoid

M is therefore independent of `R\_{2}`

Combination of inductance

Series: L\_{eff} = L\_{1} +L\_{2} +………

Parallel: 1/L\_{eff} = 1/L\_{1} + 1/L\_{2} +…..

Growth and decay in an L-R circuit

E/R = i\_{0}text( )L/R = tau\_{L]

i = i\_{0}(1 – e^((-t)/tau\_{L}))

i is the growth in current as sson as key is given, `i\_{0}`is the current at t = `infty` (steady state), max current

tau\_{L} = L/R = time constant

`i\_{0]` (final current) don’t depend on L

Relation between time and time constant

t\_{1/2} = ln(2)tau\_{L}

energy dissipiated

E = i^2R + Li(di)/(dt)

Here source gives energy of `i^2R = Vi`, and the remaining energy provided by the inductor

Decay of current

i\_{L} = i\_{0}e^((-t)/tau\_{L})

for capacitor : i\_{c} = i\_{0}e^((-t)/(RC))

at tau\_{L} = t i=37%i\_{0}

ooscillatiojn in LC circuit

potential difference across capacitor = p.d accrosss inductor

detailed derivation in book

(d^2q)/(dt^2) = -1/(LC) q

(anolog to spring masss system)

omega = 1/(sqrt(LC))

induced electric field

oint E\*dl = (-dphi\_{B})/(dt)

caused by changing magnetic field

El = (dphi\_{B})/(dt) = A (dB)/(dt)

El = A(dB)/(dt)

A is area and l is the length

Transformer

Device used to increase or decrease the voltage in an AC cirwcuit through mutual indiuctipon

It consists of teo coils, one coil connected to input called primary, coil connected to output secondary coil.

An AC current passing through primary coil creates a continuously changing flux thorugh the core. This changing flux induces an alternating emf in the secondary coil

Phi\_{p} flux per unit turn in primary coil

phi\_{p}/N\_{p} = phi\_{s}/N\_{s}

(primary is the input, secondary is output)

In ideal transformer no loss of power through eddy current , hysteresis, heating etc

V\_{s}/V\_{p} = e\_{s}/e\_{p} = N\_{s}/N\_{p} = i\_{p}/i\_{s}

Step up transformer , N\_{s}> N\_{p} increase voltage and reduces current

Step down transformer, N\_{p} >N\_{s} increase current and reduce voltage

Back emf of motors

E = applied V – potential drop(IR)

Resistance of inductor when swith closed moment is infinity

Resitance of inductoir after swith closed for long time is 0

delta q = (delta phi)/R