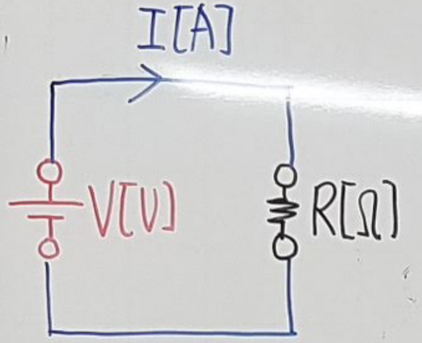
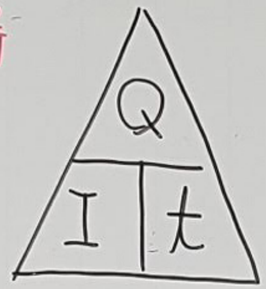
1. 전기의 기초



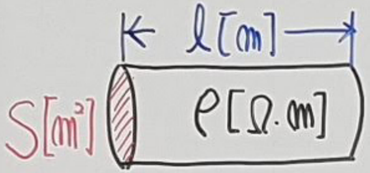
(와유)전자 : -1.602×10^{-19}[C] 전하량Q

⊖ → 이동 : 전류

⊕ 양성자+중성자 = 원자핵



※ 전선의 저항.



$S=\pi r^2=\frac{\pi}{4}D^2$

$R[\Omega]=\rho\times\frac{l}{S}$: 비례 / : 반비례

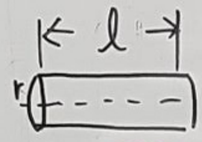
저항 → G[℧] 컨덕턴스

고유저항 → K[℧/m] 도전률, 전도률 (은 > 구리 > 금 > 알루미늄)

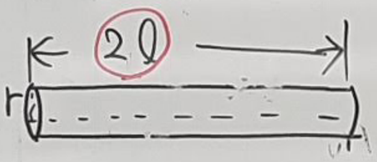
(참고) 저항변화.

R[Ω]

$(\frac{1}{4})R[\Omega]$



R[Ω]



(2)R[Ω]

(결론) 면적에는 반비례

(반)지름에는 제곱에 반비례

(결론) 길이에는 비례.

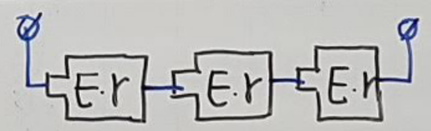
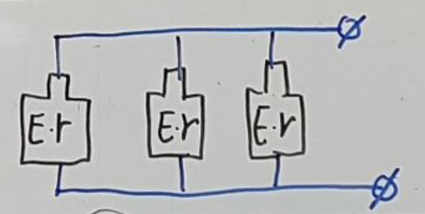
2. 전기회로의 접속

1) 부하접속(R, L, C)

부하	기호	심벌	직렬	병렬
저항	R[Ω]		R_1+R_2	$\frac{R_1\times R_2}{R_1+R_2}$
코일 (인덕턴스)	L[H]		L_1+L_2	$\frac{L_1\times L_2}{L_1+L_2}$
콘덴서 (정전용량)	C[F]		$\frac{C_1\times C_2}{C_1+C_2}$	C_1+C_2
컨덕턴스	G[℧]		$\frac{G_1\times G_2}{G_1+G_2}$	G_1+G_2

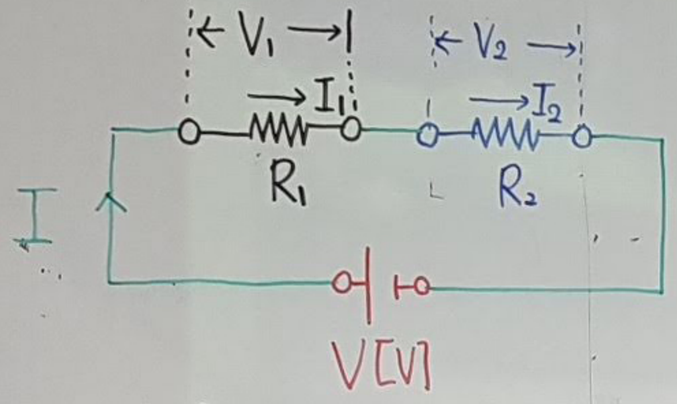
※ L은 상호인덕턴스 존재 $L(직)=L_1+L_2+2M$ $L(병)=\frac{L_1\cdot L_2-M^2}{L_1+L_2\mp2M}$

2) 전원(건전지)의 직·병렬 접속

전원(건전지) 연결		내부저항	단자전압
직렬		증가 r×3(갯수)	증가 E×3(갯수)
병렬		감소 r/3(갯수)	불변 E[V]

3. 전압·전류분배 법칙.

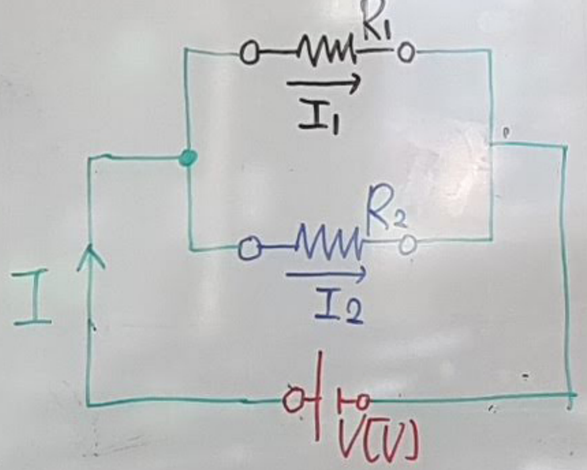
1) 전압분배 법칙 (직렬회로, 전류일정)



- 키르히호프 2법칙.
  Σ기전력 = Σ전압강하
- 직렬회로 ; 전류일정

① $R = R_1 + R_2$ ② $V_1 = V \times \frac{R_1}{R_1+R_2}$ $(V \propto R)$

2) 전류분배법칙 (병렬회로, 전압일정)

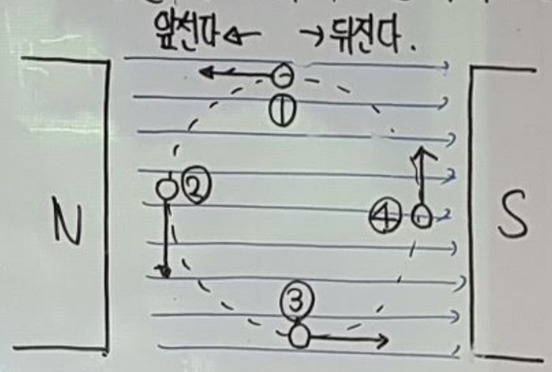


- 키르히호프 1법칙
  Σ유입전류 = Σ유출전류
- 병렬회로 : 전압일정

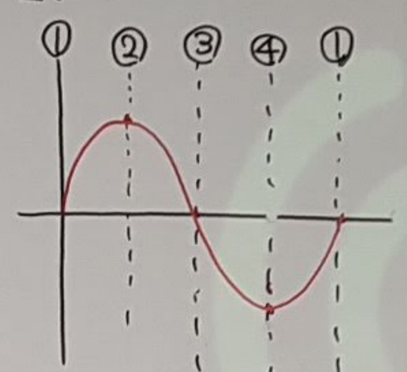
① $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ ② $I_1 = I \times \frac{R_2}{R_1+R_2}$ $(I \propto \frac{1}{R})$

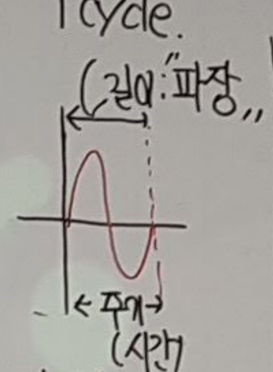
$\Rightarrow R = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}} = \frac{R_1 \cdot R_2}{R_1+R_2}$

4. 정현파 교류의 순서치 표현.



$e = BVl \sin\theta$ (플레밍)





1) 순서치 $V(t) = V_m \sin(\omega t \pm \theta)$

↳ 높이(최대값)이 V_m인 Sin형태로 변화되는파가 大초에는 얼마의 크기가 되는지를 나타냄

① V_m : 최대값

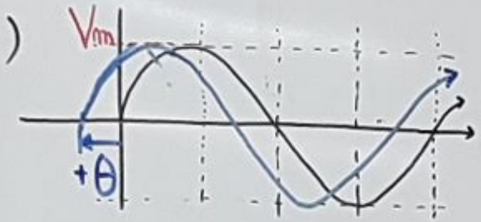
② $\omega = 2\pi f = 2\pi \frac{1}{T}$

- ω(각속도) $= \frac{\text{각의 변화 [rad]}}{\text{시간 [Sec]}}$
- f(주파수) $= \frac{\text{사이클수 (cycle)}}{\text{시간 [Sec]}}$
- T(주기) $= \frac{\text{시간 [Sec]}}{\text{사이클당 (cycle)}}$

③ θ : 위상(°). [rad] ⇨ 실제는 [°]도환산

4. 정현파 교류의 순시치 표현

1)

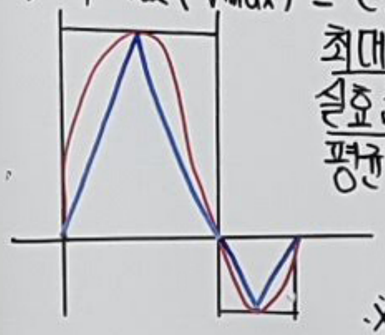


위상

$V(t) = V_m \sin(\omega t + \theta)$

↳ 최대값 $= \sqrt{2}\, V_{rms}$

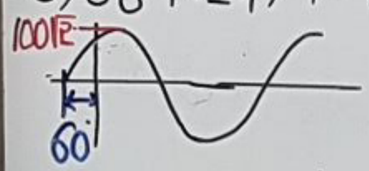
2) 최대값(V_{max}) ≥ 실효값(V_{rms}) ≥ 평균값(V_{av})

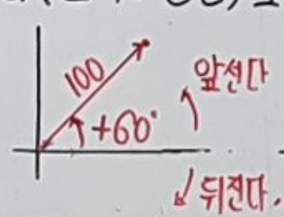


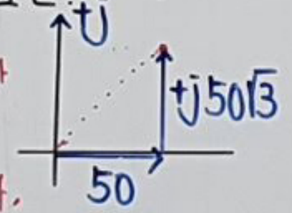
	구형파 (직류)	정현파 (교류)	삼각파 (톱니파)
최대값 / 실효값 = 파고률 =	1	$\sqrt{2}$	$\sqrt{3}$
실효값 / 평균값 = 파형률 =	1	1.11	1.155

※ 반파 = 전파 × $\sqrt{2}$

3) 정형파(교류)의 벡타(크기+방향) 표현







◎ 순시치 $V(t) = 100\sqrt{2}\sin(\omega t + 60)$
$= 141\sin(\omega t + 60)$

① 극좌표 $V(t) = 100\angle 60$; 실효값∠위상.

② 삼각함수 $V(t) = 100(\cos 60° + j\sin 60)$

③ 복소수 $V(t) = 50 + j50\sqrt{3}$

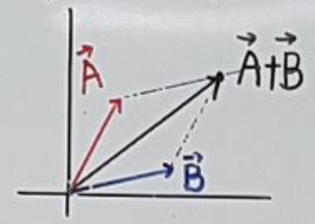
①' 극좌표 $= \sqrt{실^2 + 허^2}\ \angle \tan^{-1}\left(\frac{허}{실}\right)$

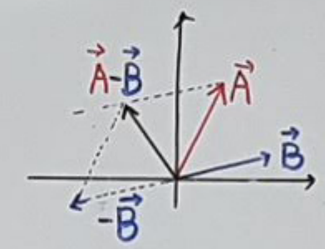
$= \sqrt{50^2 + (50\sqrt{3})^2}\ \angle \tan^{-1}\left(\frac{50\sqrt{3}}{50}\right) = 100\angle 60$

4) 벡타의 연산

① 극좌표 $\vec{A} = A\angle\theta_1$, $\vec{B} = B\angle\theta_2$

◎ $|\vec{A} \pm \vec{B}| = \sqrt{A^2 + B^2 \pm 2AB\cos(\theta_1 - \theta_2)}$





◎ $\vec{A} \times \vec{B} = (A \times B)\angle(\theta_1 + \theta_2)$

◎ $\vec{A} / \vec{B} = (A/B)\angle(\theta_1 - \theta_2)$

② 복소수 $\vec{A} = a + jb$, $\vec{B} = c + jd$

◎ $\vec{A} \pm \vec{B} = (a + jb) \pm (c + jd)$
$= (a \pm c) + j(b \pm d)$: 끼리끼리.

◎ $\vec{A} \times \vec{B} = (a + jb) \times (c + jd)$
$= ac + jad + jbc + j^2bd$
$= (ac - bd) + j(ad + bc)$

◎ $\vec{A} / \vec{B}$ = 분모유리화. 그리고 배분법칙.

※ $j = \sqrt{-1}$, $j^2 = -1$, $j^3 = -j$, $j^4 = 1$

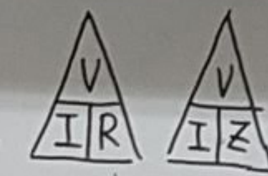
$\frac{1}{j} = -j$

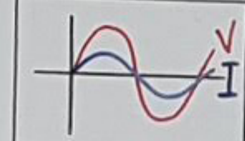
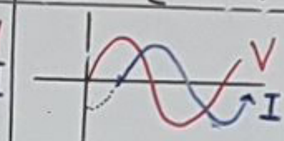
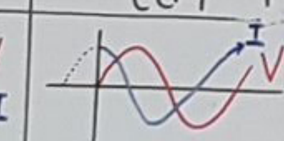
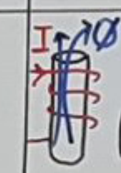
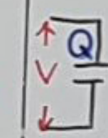
※ $j = 1\angle 90$, $j^2 = 1\angle 180$, $j^3 = 1\angle 270$
↳ $1\angle -90$

$j^4 = 1\angle 360$

5. 교류회로

1) 기본교류회로



R[Ω] 저항	L[H] 인덕턴스 코일	C[F] 정전용량 콘덴서
		
V.I 동위상	전류뒤짐. 급변불가 → 지상전류(뒤진전류)	전압뒤짐. 급변불가 → 진상전류(앞선전류)
R[Ω]	$j\omega L = jX$ (유도성)리액턴스	$\frac{1}{j\omega C} = -j\frac{1}{\omega C} = -jX$ (용량성)리액턴스
	 $N\phi = LI$, $W_L = \frac{1}{2}LI^2$	 $Q = CV$, $W_C = \frac{1}{2}CV^2$

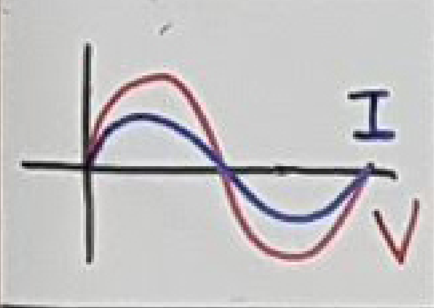
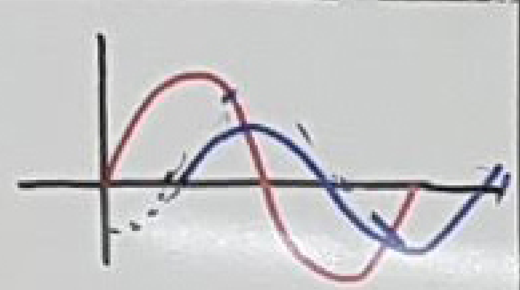
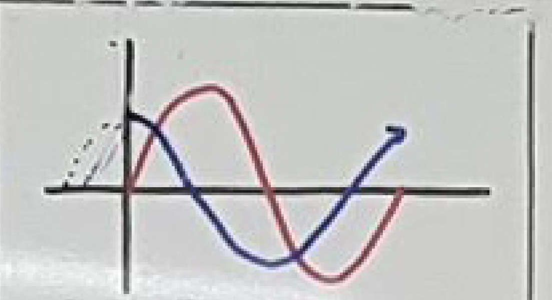
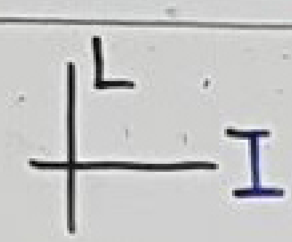
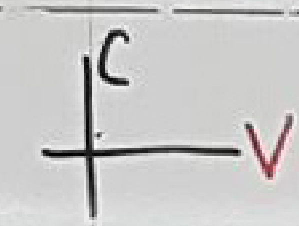
◎ $Z = R \pm jX$ (임피턴스, 저항, 리액턴스)
유도성(코일-m-)
용량성(콘덴서-ㅏ)

◎ $Y = G \mp jB$ (어드미턴스, 콘덕턴스, 서셉턴스)
유도성
용량성

5. 교류회로

1) 기본회로

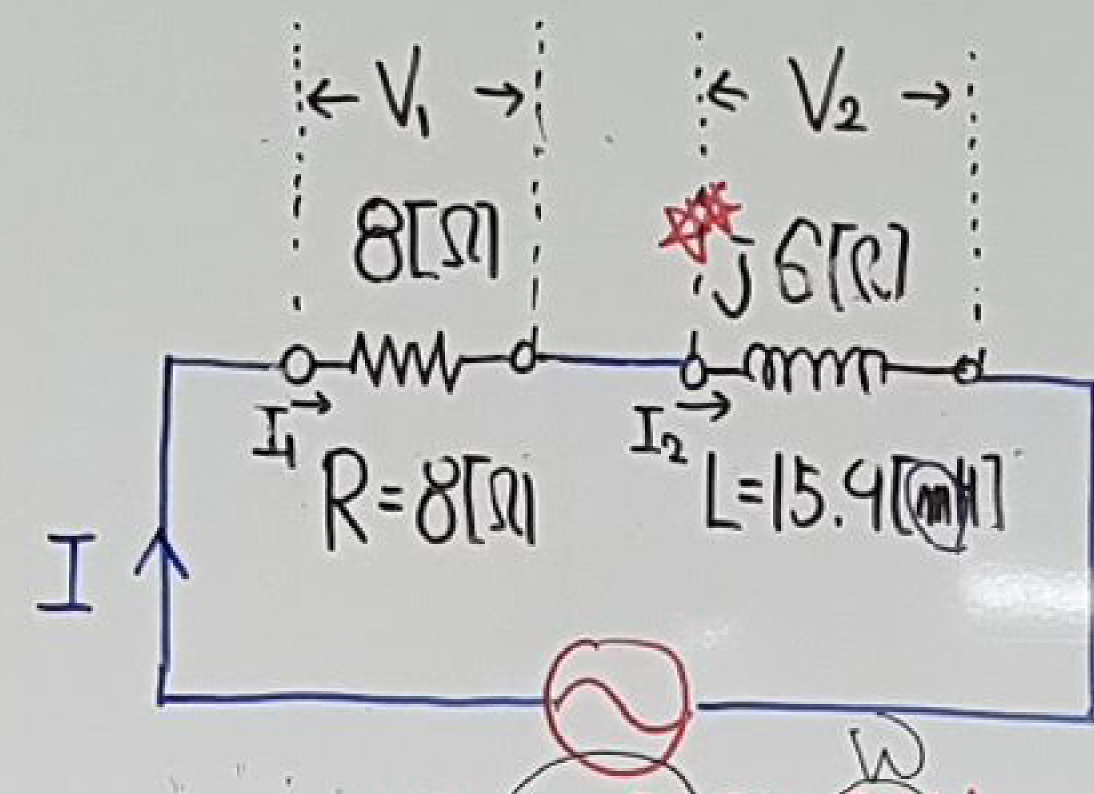
$\frac{V}{I \cdot R}$ $\frac{V}{I \cdot Z}$

R[Ω] 저항	L[H] 인덕턴스. 코일	C[F] 정전용량. 콘덴서
		
		
V.I 동위상.	전류뒤짐. 급변불가 →지상전류(뒤진전류)	전압뒤짐. 급변불가 →진상전류(앞선전류)
R[Ω]	$j\omega L = jX$[Ω] (유도성) 리액턴스	$\frac{1}{j\omega C} = -j\frac{1}{\omega C} = -jX$ (용량성) 리액턴스
	$N\phi = LI$, $W = \frac{1}{2}LI^2$	$Q = CV$, $W = \frac{1}{2}CV^2$

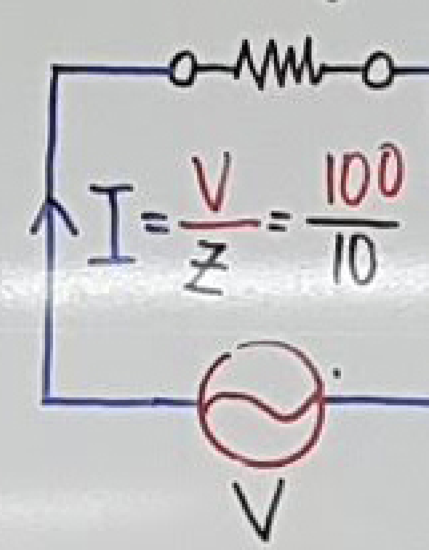
Z[Ω] = $R \pm jX$ ($+j$: 유도성(L), $-j$: 용량성(C))
임피던스 　 저항 　 리액턴스

Y[℧] = $G \mp jB$ ($-j$: 유도성(L), $+j$: 용량성(C))
어드미턴스 　 컨덕턴스 　 서셉턴스

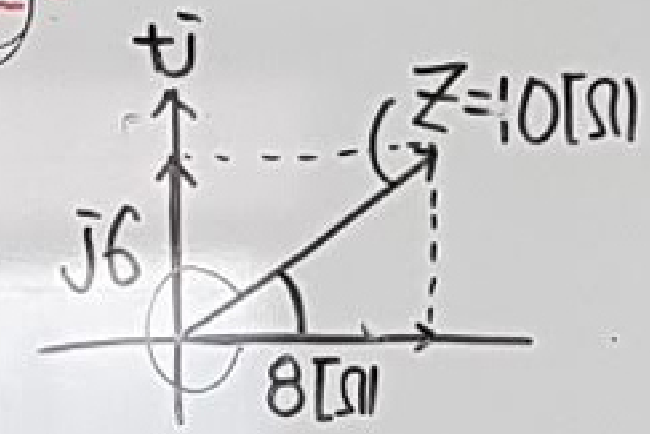
2) 기본합성 교류회로 (R-L 직렬. 전류일정)



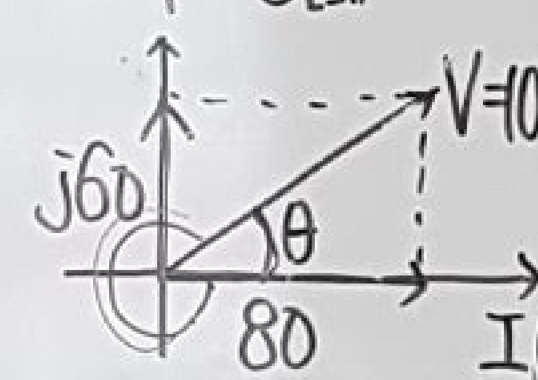
$V(t) = 100\sqrt{2}\sin 377t$



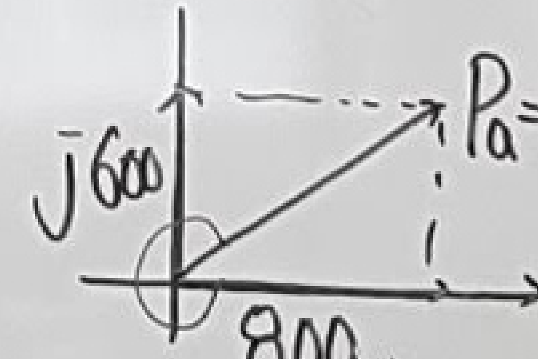
① $Z = Z_1 + Z_2 = 8 + j6 = \sqrt{8^2+6^2} = 10.$



② $V = V_1 + V_2 = 80 + j60 = \sqrt{80^2+60^2} = 100$



③ $P_a = P_1 + P_2 = 800 + j600 = \sqrt{800^2+600^2} = 1000$



④ 역률 ($\cos\theta$) : θ → V.i의 위상차.

$\cos\theta = \frac{\text{유효전력}}{\text{피상전력}} = \frac{R}{\sqrt{R^2+X^2}}$ (직렬) $= \frac{X}{\sqrt{R^2+X^2}}$ (병렬)

[참고]

1) 옴의 법칙.

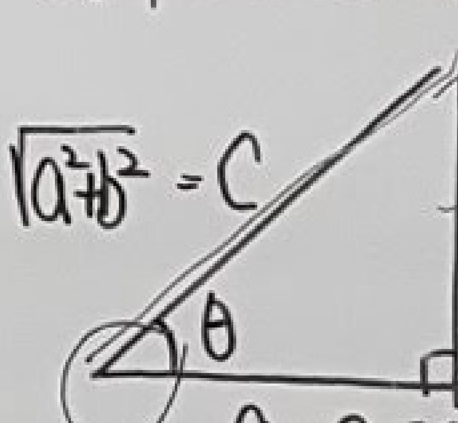
- $V = I \cdot Z$ → $I = V/Z$
- $V_1 = I_1 \cdot Z_1$ → $I_1 = V_1/Z_1$
- $V_2 = I_2 \cdot Z_2$ → $I_2 = V_2/Z_2$

2) 전력.

: P_a[VA]: 피상. P[W]: 유효. P_r[Var]: 무효

- $P_a = VI = I^2 Z = V^2/Z$
- $P = V_1 I_1 = I_1^2 Z_1 = V_1^2/Z_1$
- $P_r = V_2 I_2 = I_2^2 Z_2 = V_2^2/Z_2$

3) 실수(유효분. 저항), 허수(무효분. 리액턴스) 의 합.



$\sqrt{a^2+b^2} = C$

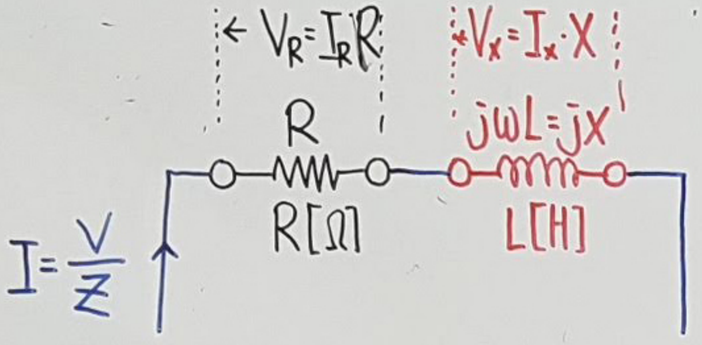
$b = C \times \sin\theta$: 무효분

$a = C \times \cos\theta$: 유효분

$\sin^2 + \cos^2 = 1$ ($\sin\theta = 0.6$, $\cos\theta = 0.8$ / 〃 0.8, 〃 0.6)

2. 기본 합성회로.

① R-L 직렬 연결.



⓪ $Z = R + jX$

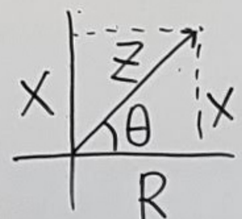
① $I\left(=\frac{V}{Z}\right) = I_R\left(=\frac{V_R}{R}\right) = I_X\left(=\frac{V_X}{X}\right)$

② 유효전력 $P[W] = V_R I_R = I_R^2 \cdot R \propto I^2$

무효전력 $P_r[Var] = V_X I_X = I_X^2 \cdot X$

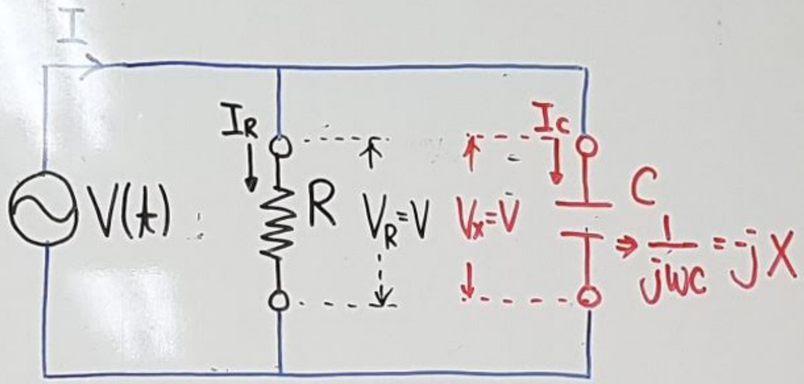
③ 역률 $(\cos\theta) = \frac{\text{유효전력}}{\text{피상전력}} = \frac{R}{\sqrt{R^2+X^2}}$

④ 위상각 $\theta = \tan^{-1}\left(\frac{X}{R}\right)$



$\tan^{-1}\left(\frac{X}{R}\right)$

② R-C 병렬 회로.



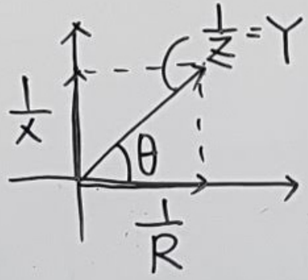
⓪ $Z = \frac{R \cdot (-jX)}{R + (-jX)} = \frac{R \cdot X}{\sqrt{R^2+X^2}}$

① $I = I_R + I_X = \frac{V}{R} + \frac{V}{-jX} = \sqrt{I_R^2 + I_X^2}$

② 유효전력 $P[W] = V_R I_R = \frac{V_R^2}{R} \propto V^2$

③ 역률 $(\cos\theta) = \frac{\text{유효전력}}{\text{피상전력}} = \frac{X}{\sqrt{R^2+X^2}}$

④ 위상각 $\theta = \tan^{-1}\left(\frac{R}{X}\right)$

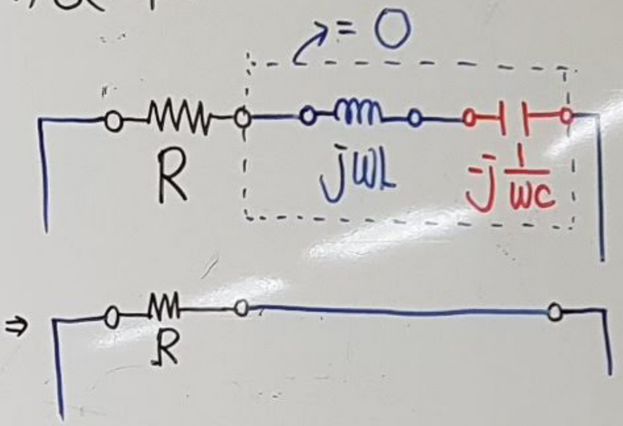


$\tan^{-1}\left(\frac{\frac{1}{X}}{\frac{1}{R}}\right)$

3) 위상각 (전압·전류의 위상차)

○ 직렬 : $\tan^{-1}\left(\frac{X}{R}\right)$ ○ 병렬 : $\tan^{-1}\left(\frac{R}{X}\right)$

4) 공진회로.



① 직렬공진 : $R + j\omega L - j\frac{1}{\omega C} = R$

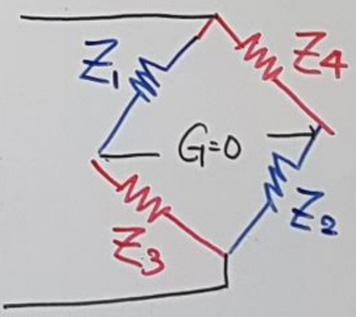
⓪ 공진조건 : $\omega L = \frac{1}{\omega C}$

① 공진주파수 : $f = \frac{1}{2\pi\sqrt{LC}}$

② 공진결과 : Z(최소), I(최대)

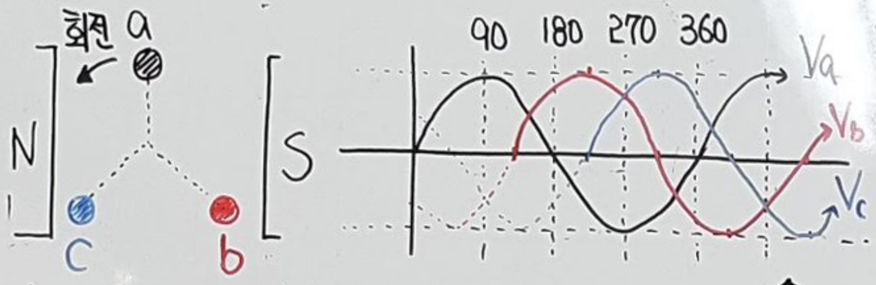
② 병렬공진 : Z(최대), I(최소)

5) 브리지 평형조건. (G=0)



$Z_1 \cdot Z_2 = Z_3 \cdot Z_4$

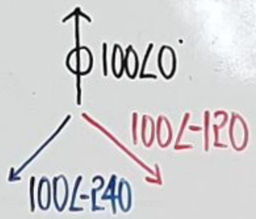
6.3상교류회로 (상간 위상차 120° = $\frac{2}{3}\pi$)



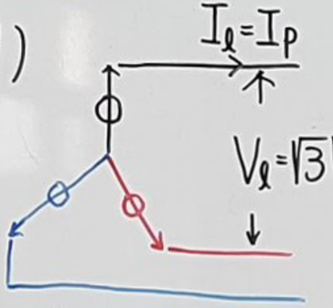
$V_a = 141\,Sin(wt) = 100\angle 0°$

$V_b = 141\,Sin(wt-120) = 100\angle -120$

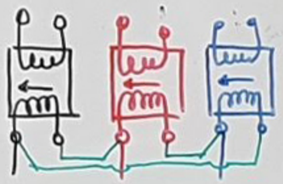
$V_c = 141\,Sin(wt-240) = 100\angle -240$

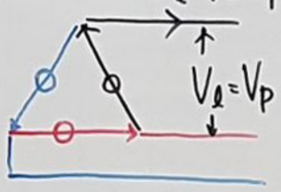


1) Y결선 (성형결선, 스타결선)



2) △결선 (환상결선, 델타결선)





3) V결선 : 1φ변압기 2대로 3상전력공급

- 공급용량 = $P_{1\phi} \times \sqrt{3}$
- 이용률 = $\frac{P_{1\phi} \times \sqrt{3}}{P_{1\phi} \times 2}$

암기	Y	△
	V	I
	30°앞	30°뒤

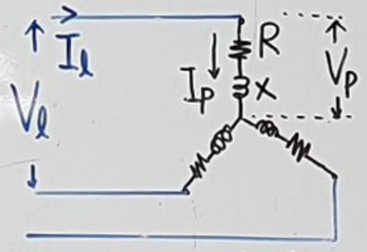
Y결선 : $V_l = \sqrt{3} V_p \angle +30$

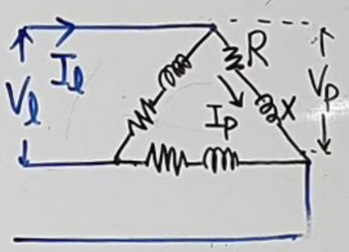
△결선 : $I_l = \sqrt{3} I_p \angle -30$

7.3상 부하의 결선.

※선간값은 상값 계산후 환산.

1) 부하의 Y결선, △결선.





- $I_p = \frac{V_p}{Z_p} = \frac{V_l/\sqrt{3}}{\sqrt{R^2+X^2}}$
- $I_l = I_p$

- $I_p = \frac{V_p}{Z_p} = \frac{V_l}{\sqrt{R^2+X^2}}$
- $I_l = \sqrt{3} I_p$

2) 부하의 Y결선(1), △결선(3) 비교

① 동일저항을 Y결선서 △결선과 비교서 ($\frac{1}{3}$)

② (Y기동→△운전)을 (△기동→△운전)에 비해

Y-△기동 / 전전압 기동

기동전류, 기동토크 모두 ($\frac{1}{3}$)로 감소

8.전력.

- 유효전력 (R, cosθ)
- 무효전력 (X, Sinθ)

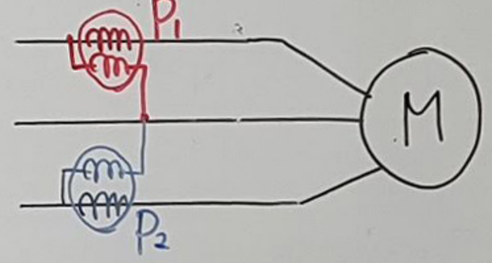
1) $P_{3\phi}$ (유효전력) $= 3 V_p I_p \cos\theta$

$= \sqrt{3} V_l I_l \cos\theta$

2) $P_{3\phi}$ (유효전력) $= 3 I^2 \cdot R$ (직렬)

$= 3 \frac{V^2}{R}$ (병렬)

3) 2전력계법



① 3상 유효전력 = $P_1 + P_2$

② 3상 피상전력

$= 2\sqrt{P_1^2 + P_2^2 - P_1 P_2} = \sqrt{3} V_l I_l$

9. 비정현파 ; 푸리에 분석.

1) 구성 ; ① 직류분 + ② 고조파 + ③ 기본파 (여러주파수의 합)

2) 실효값 : 각파의 실효값의 제곱의 합의 제곱근.

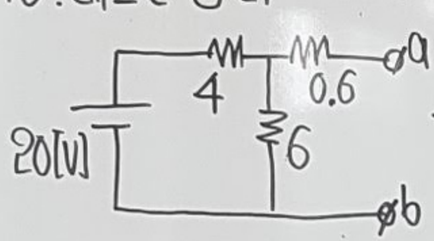
3) 전력 ; 같은 주파수끼리의 전력의 합.

4) 왜형률 : ② 고조파의 실효값의 합 / ③ 본파의 실효값

ex) $V(t) = 10\sqrt{2}\sin(\omega t) + 5\sqrt{2}\sin(3\omega t + 30)$

$i(t) = 2 + 5\sin(\omega t + 30) + 10\sin(3\omega t + 60)$

10. 테브난 정리 ⇄ 노튼 정리와 쌍대적.



$Z_{ab} = 0.6 + \frac{4\times6}{4+6}$

$V_{ab} = 20 \times \frac{6}{4+6}$

11. 키르히호프 { 제1법칙 : $\sum$유입전류 = $\sum$유출전류 / 제2법칙 : $\sum$기전력 = $\sum$전압강하.

12. 과도현상.

1) 시정수 ≒ 과도시간 (Sec. 초) : 최종변화의 63%

2) 시정수 ; RL $(\frac{L}{R})$. RC (RC). LC $(\sqrt{LC})$

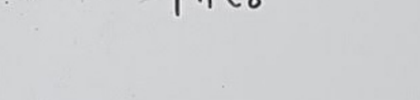
13. 클롱의 법칙.

1) 물질분석 : 물질 → 분자 → 원자 (원자핵 [양성자. 중성자] 전자)

⊖ : 전자 { 전하량 : -1.602×10^{-19} [C] / 질 량 : 9.1×10^{-31} [kg]

2) 두전하사이의 힘 (같은극성 : 반발. 다른극성 : 흡인)

F[N]. Q[C]. r[m]



$F = \frac{Q_1 Q_2}{4\pi\varepsilon r^2}$

$F_0 = 9\times10^9 \frac{Q_1 Q_2}{r^2}$

※ ε(유전률) = $\varepsilon_s \cdot \varepsilon_0$

ε_0 → 진공(공기)의 유전률 $= 8.855\times10^{-12}$ [F/m]

ε_s → 비유전률 (단위없음)

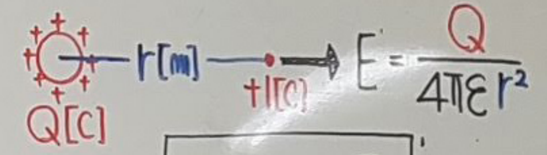
산화티탄 > 운모 > (공기 ≒ 1)

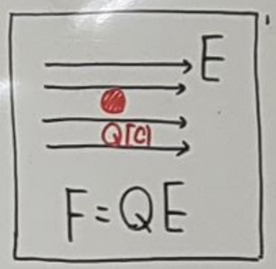
$\therefore \frac{1}{4\pi\varepsilon_0} = 9\times10^9$

14. 전계 (전장의세기. 절연내력)

; 전하 주변에 +1[C](단위정전하)가 받는힘.

1) 전계의 세기. E [V/m] [N/C]





2) 전기력선 ; 전계(전기장)의 가상선.

① ⊕ → ⊖

② 전위가 높은곳 → 낮은곳.

③ 그 자신만으로는 폐곡선이 되지 않는다.

④ 도체(등전위면)과 수직(직교)한다.

⑤ 전기력선 끼리는 교차하지 않는다

⑥ 전기력선의 밀도 (갯수/면적) = 전계

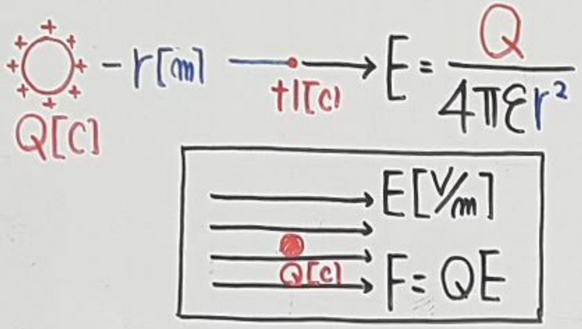
⑦ 도체내부 { 전하(밀도) = 0 / 전계(전기력선) = 0 / 전위 = 표면전위 }

⑧ 전기력선수 = $\frac{Q}{\varepsilon}$ 전속 = Q (= 페르데이관)

14. 전계 (전기장의세기, 절연내력)

: 전하 주변에 +1[C]이 받는 힘

1) 전계의 세기 : E[N/C] [V/m]



2) 전기력선 ; 전계(전기장)의 가상선

① ⊕ ⇒ ⊖

② 전위가 높은곳 → 낮은곳

③ 도체(등전위면)과 수직(직교)한다.

④ 전기력선 끼리는 교차하지 않는다.

⑤ 전기력선은 그 자신만으로 폐곡선안됨.

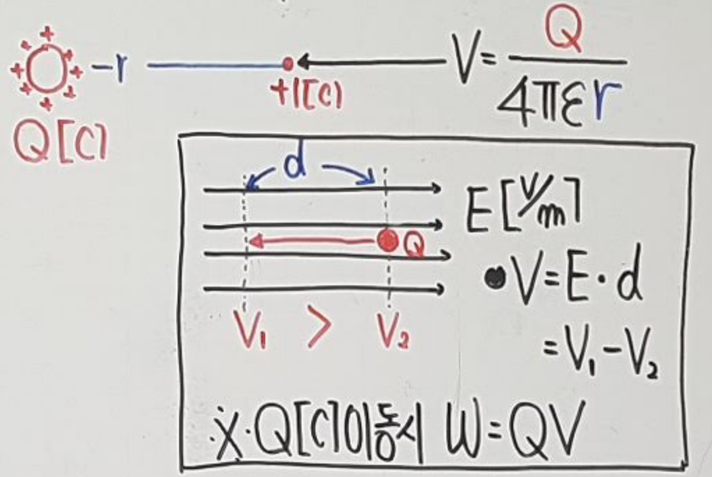
⑥ 전기력선 밀도(갯수/면적) = 전계

⑦ 전기력선수($\frac{Q}{\varepsilon}$) : 전속선수 = Q (=패러데이관수)

⑧ 도체내부 { 전계(전기력선) = 0 / 전하(전하밀도) = 0 / 전위 = 표면전위.

15. 전위

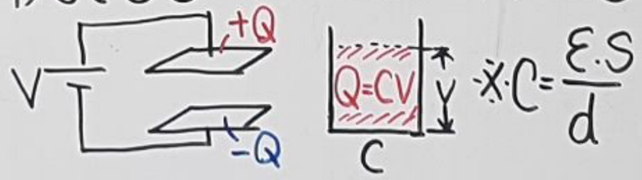
: 전계내에서 +1[C]를 옮기는데 필요한일



※ 전하밀도 $D[C/m^2]=\varepsilon E$

16. 정전용량 C[F]

1) 정전용량 C[F] : 전하를 축적하는 능력.



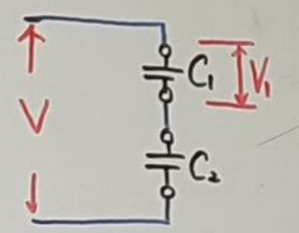
2) 정전에너지 W[J] : 축적되는에너지

$W[J]=\frac{1}{2}CV^2=\frac{1}{2}QV=\frac{Q^2}{2C}$

$F[J/m^3]=\frac{1}{2}\varepsilon E^2=\frac{1}{2}DE=\frac{D^2}{2\varepsilon}$

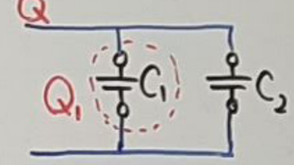
3) 콘덴서의 합성.

① 직렬.



- $C=\frac{C_1\times C_2}{C_1+C_2}$
- $V_1=V\times\frac{C_2}{C_1+C_2}$

② 병렬.



- $C=C_1+C_2$
- $Q_1=Q\times\frac{C_1}{C_1+C_2}$

4) 콘덴서의 종류.

① 전해콘덴서 (산화피막)

② 세라믹콘덴서 (산화티탄)

③ 마이카콘덴서 (운모) : 마이카로 운전~.

④ 바리콘 콘덴서 : 가변용량.

17. 전류의 전기현상.

1) 표피효과 : 표면에만 전류

2) 핀치효과 : 중심에만 전류

3) 열기전력 : (온도→전류) : 전자온도계 (제어벡)

4) 펠티에 : (전류→온도) : 전자냉장고

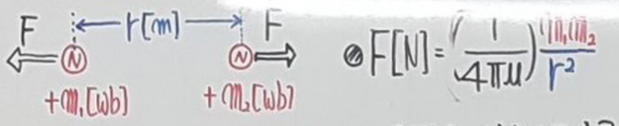
5) 톰슨 : (동일금속)

6) 홀(Hall) : 외부자계(H)→전류제한

7) 압전기 : 기계적 압력 → 분극전하(전기)

8) 파이로전기 : 가열(온도) → 분극전하(전기)

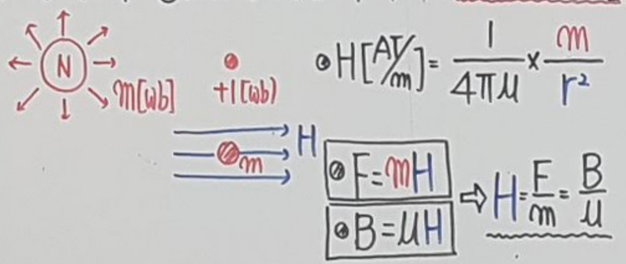
18. 쿨롱의 법칙 : 자하(극) m , Ø [wb]



- $F[N] = \left(\frac{1}{4\pi\mu}\right)\frac{m_1 m_2}{r^2}$

※ $\mu\left[\frac{H}{m}\right] = \mu_s\mu_0$ (투자율)
- $\mu_0 = 4\pi\times10^{-7}\left[\frac{H}{m}\right]$: 진공의 투자율
- $\mu_s > 1$: 상자성체 (강자성체 : 철, 니, 코, 망)
- $\mu_s < 1$: 반자성체 (반강자성체)

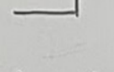
19. 자계 (자기장) ; 자하(극) 주위에 +1[wb]가 받는 힘



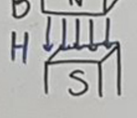
- $H\left[\frac{AT}{m}\right] = \frac{1}{4\pi\mu}\times\frac{m}{r^2}$
- $F = mH$
- $B = \mu H$

$\Rightarrow H = \frac{F}{m} = \frac{B}{\mu}$

20. 에너지 W[J][J/m³] . 힘 F[N/m²]

1) 

$W[J] = \frac{1}{2}LI^2$ (전자 에너지)

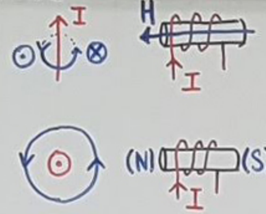
2) 

$W\left[\frac{J}{m^3}\right] = \frac{1}{2}BH = \frac{1}{2}\mu H^2 = \frac{B^2}{2\mu}$

$F\left[\frac{N}{m^2}\right]$

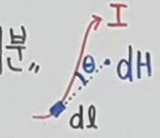
※ $B = \mu H$ $\left(H = \frac{m}{4\pi\mu r^2},\ B = \frac{m}{4\pi r^2}\right)$

21. 전류에 의한 자계

1) 방향 : 

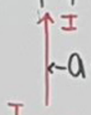
※ Ampere의 "오른손", "오른나사"

2) 크기
① Ampere의 "주회적분"
② 비오-샤바르의 법칙

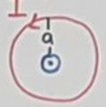


$dH = \frac{I\,dl\sin\theta}{4\pi r^2}$

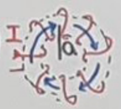
22. 전류에 의한 자계의 세기

1) 직선전류 

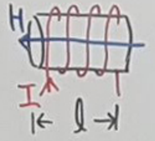
$H = \frac{NI}{2\pi a}$

2) 원형전류중심 

$H_0 = \frac{NI}{2a}$

3) 환상코일(내) 

$H = \frac{NI}{2\pi a}$

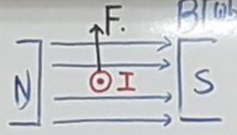
4) 무한코일(내) 

$H = \frac{NI}{l}$

※ $\frac{1}{4\pi\mu_0} = 6.33\times10^4$

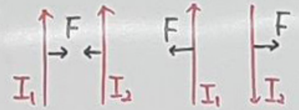
23. 전자력 F[N], 회전력 T[N·m]

1) 전자력
① 자계내 직선전류



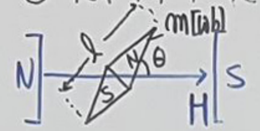
- $F = BIl\sin\theta = (I\times B)l$
; 플레밍의 왼손법칙 (FBI) 전동기

② 두 직선전류 사이



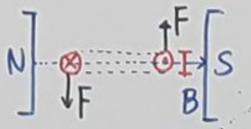
- $F = \frac{2I_1I_2}{r}\times10^{-7}[N/m]$ { 동일 : 흡인, 왕복 : 반발 }

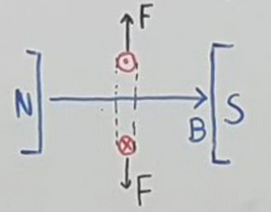
2) 회전력
① 막대자석의 회전력 : ex) 나침판



$T = MH\sin\theta$
$= (m\cdot l)H\sin\theta$

② 평판코일의 회전력 : "전동기"



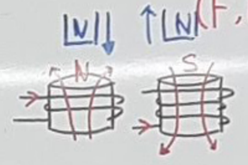


$T = NBSI\cos\theta$
$= NBSI'\cos\theta'$

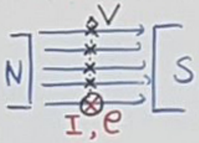
θ = 평판과 자계
θ' = 평판의 수직성분과 자계

24. 유도기전력의 원리

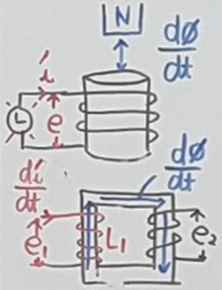
1) 방향 : ① 렌츠의 법칙 ; 자속의 변화를 방해
② 플레밍의 오른손 ; 운동하는 도체에



$(F, B.I) \leftrightarrow (V, B.e)$

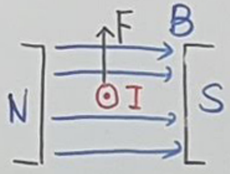


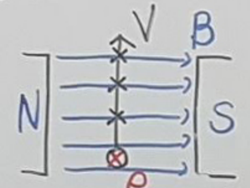
2) 유도기전력의 크기
① 페러데이-노이만의 법칙 ⇨ 자속쇄교수의 감소비율과 같다



- $e = -N\frac{d\varnothing}{dt}$
- $e_1 = -L_1\frac{di_1}{dt}$
- $e_2 = -M\frac{di_1}{dt}$

② 플레밍의 오른손 법칙



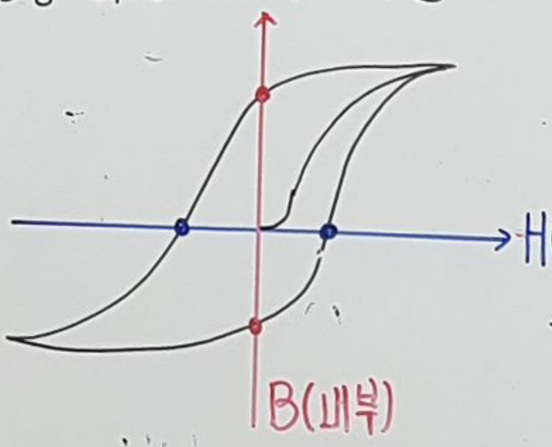


$F = BIl\sin\theta$
- 엄지 : F (힘)
- 인지(검지) : B (자계)
- 중지 : I (전류)

$e = Bvl\sin\theta$
- 엄지 : V (속도)
- 인지(검지) : B (자계)
- 중지 : e (유도기전력)

25. 히스테리시스 곡선과 자성체

1)



① 전류자기 ; 증축.

② 보자력 ; 횡축

※ 히스테리시스손(구소) $\propto B^{1.6\sim2} \propto f$

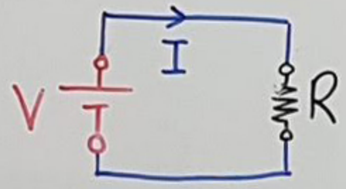
와전류손 (성층) $\propto B^2 \propto f^2$

2) 자성체 ; 영구자석(모두크다), 전자석(전류자기 만크다)

① 강(상)자성체 ; 철, 니켈, 코발트, 망간 ($\mu_s >> 1$)

② 반(강)자성체 ; 은, 구리 ($\mu_s < 1$)

26. 전기회로 ($V = I \cdot R$) 과 자기회로

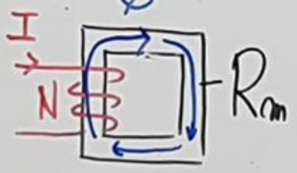


$V = I \cdot R$

기전력 전류 저항

◎ $I = \frac{Q}{t}$

◦ $R = \rho \frac{l}{S} = \frac{l}{KS}$



$F = \emptyset \cdot R_m$

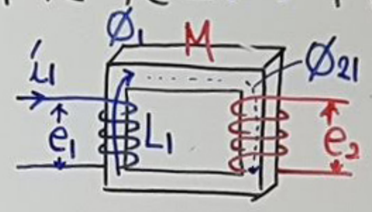
기자력 자속

◦ $F = NI\,[AT]$

◦ $\emptyset\,[Wb]$

◎ $R_m = \frac{l}{\mu S} = \frac{F}{\emptyset}$

27. 자기인덕턴스(L)과 상호인덕턴스(M)



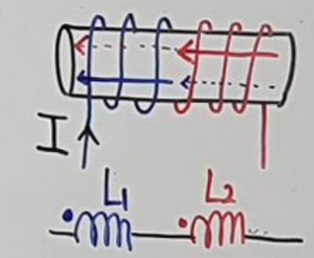
1) 자기인덕턴스(L) ; $N_1\emptyset_1 = L_1 I_1$ ⇨ $L_1 = \frac{\mu S N^2}{l} \propto N^2$

2) 상호인덕턴스(M) ; $N_2\emptyset_{21} = M I_1$ ⇨ $M = \frac{\mu S N_1 N_2}{l}$

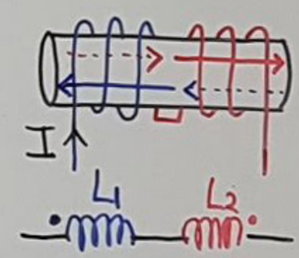
※ $M = K\sqrt{L_1 L_2}$; K(결합계수 0~1)

3) 인덕턴스의 합성 ($N\emptyset = LI$)

① 직렬접속

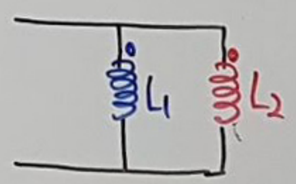


(가) $L = L_1 + L_2 + 2M$

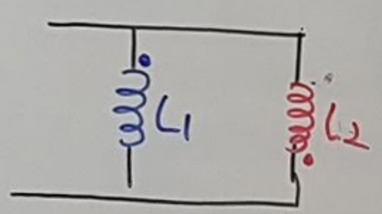


(감) $L = L_1 + L_2 - 2M$

② 병렬접속



(가) $L = \frac{L_1 L_2 - M^2}{L_1 + L_2 - 2M}$



(감) $L = \frac{L_1 L_2 - M^2}{L_1 + L_2 + 2M}$

※ 기타, 전기기능사에 출제되는 내용

1. 저항 측정
   ① 휘트스톤 브리지 ; 표준 브리지, 고저항 가는전선.
   ② 캘빈더블 〃 ; 정밀, 저 저항, 굵은전선
   ③ 콜라우시 〃 ; 접지저항, 전해액의 저항.
2. 열역학 제 2법칙 ; 열(고온 → 저온)
3. 반도체 ; 불순물을 섞으면 저항감소.
   1) 4가(Si, Ge) + 3가(붕소, 갈륨, 인듐) ; P형(정공)
      + 5가(인, 비소, 안티몬) ; N형(전자)
   2) P-N 접합 반도체 ; 다이오드(정류작용)
   3) 도체만 양의 온도계수(온도↑저항↑전류↓). 그외(음의온도계수)
4. 패러데이 법칙. (전기도금)
   • W[g :석출량] = KQ = KIt ; K(화학당량) = 원자량 / 원자가
   • (+극) 물질이 녹아서(얇아짐) → (-극) 붙는다(두꺼워짐) : 도금
5. 전압계(병렬, 내부저항 ∞), 전류계(직렬, 내부저항 0)
6. ㉮배율저항과 ㉯분류저항 ; 측정범위확대.
   ① 압류 → 배분 (전압계 ; 배율저항, 전류계→분류)
   ② (배율 -1) 배로 (배율저항 = 내부저항 X ( ) / 분류저항 = 내부저항 / ( ))

7. 전지
   ① 1차전지 ; 망간건전지 (암. 1차로 망한집)
   2차전지 { - 알카리 축전지 ; (니켈, 카드뮴) ; ㉮알카니카
   - 납 〃 ; (과산화납, 납) ; ㉮납꾹과납 }
   ② 성극작용(분극작용) ; +(극)수소발생(감극제도~) ; ㉮성스러운 부수
   ③ 국부작용 ; 전지내부 불순물 → 순환전류 ; 기전력감소.
   ④ 볼타전지 ; +극(구리), -극(아연). 황산액 ; ㉮볼타는 구이~
   ⑤ 표준전지 ; +극(수은), -극(카드뮴 아말감) ; ㉮표준 수카
8. 줄의 법칙 1[J][W·S] = 0.24[cal], 1[kwh] = 860[kcal]
   ·X·전력량 = 전력[W] X 사용시간[Sec], 전력 $P = VI = I^2R = \frac{V^2}{R}$
9. 선로의 특성임피던스 $Z = \sqrt{Z_0 Z_s}$
10. 자기차폐(전자차폐) ; 자계(자기장)차단. (강자성체로 감싼다)
    전기차폐(정전차폐) : 전계(전기장) 〃 , (금속(도전체)로 〃)
11. $860Pt = C \cdot m \cdot \Delta T$ (P[kw], t[h], m[kg], ΔT[°c])
12. 비열, 코로나, 허용전류, 절연.
13. 열의 전달방법 ; 전. 빛. 대
    ① 전도 → 손잡고 ② 복사열 → 태양열 ③ 대류 → 기류.