CH2

DC (0Hz)

$V = iR$ (real)

$$\begin{cases} V = L\dfrac{di}{dt} = 0 \\ i = C\dfrac{dv}{dt} = 0 \end{cases}$$ (imaginary)

$P = VI = \dfrac{V^2}{R} = I^2R$

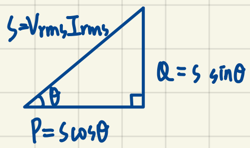
$Q = 0$

AC (60Hz)

$V = iR$

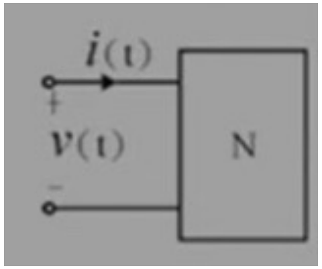
$V = L\dfrac{di}{dt} = Lsi \neq 0$

$i = C\dfrac{dv}{dt} = Csv \neq 0$ $(s = j\omega)$



$\sqrt{2}\,V_{rms} = V_m$

2.1供應單埠的複數功率
(Complex Power Supplied to a One-Port)



$v(t)=V_m\cos(\omega t+\theta_v)= \mathrm{Re}(V_m e^{j(\omega t+\theta v)})$

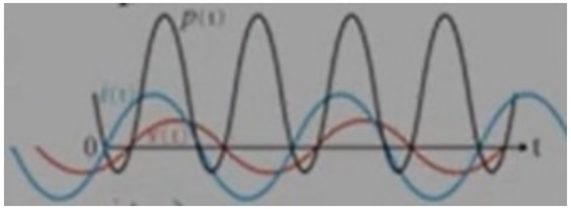
$i(t)=I_m\cos(\omega t+\theta_i)= \mathrm{Re}(I_m e^{j(\omega t+\theta i)})$

單相實功擾動

$p(t)=v(t)*i(t)=V_m\cos(\omega t+\theta_v)*I_m\cos(\omega t+\theta_i)$

可能為負

$=0.5*\underline{V_m I_m}[\cos(\theta_v-\theta_i)+\cos(2\omega t+\theta_v+\theta_i)]$



Power factor angle: $\theta=\theta_v-\theta_i$

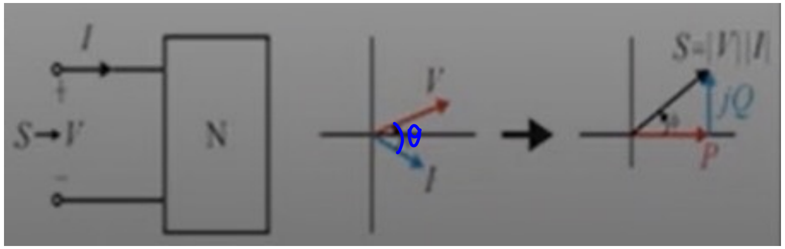
Power factor = $\cos\theta$;(lagging,leading,unity)

Average power=$0.5*V_m I_m\cos\theta=V_{rms}I_{rms}\cos\theta=\mathrm{Re}VI^*$

Power triangle $S=VI^*=P+jQ$;

|S|視在功率(VA) apparent power

S複數功率(VA) complex power



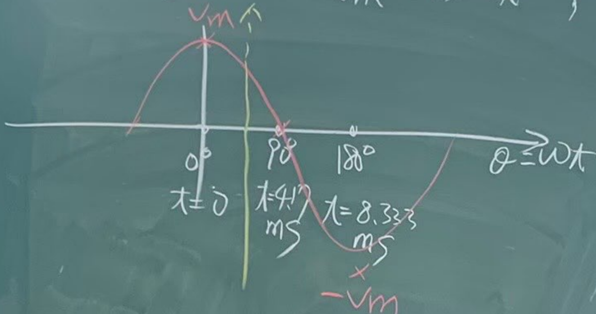
P實功(W) real power

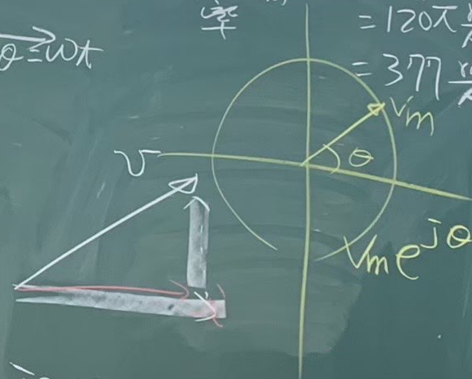
Q虛功(無效功率)(Var) reactive power

$v(t) = V_m \cos\omega t$, $\theta = \omega t$, $f = 60\ Hz$

角度 rad　角頻率　時間

$\omega = 2\pi f$
$= 120\pi \frac{rad}{sec}$
$= 377 \frac{rad}{sec}$





$V = V_{rms} e^{j\theta_v}$

$I = I_{rms} e^{j\theta_i}$

$P \neq VI = V_{rms} \times I_{rms} (e^{j\theta_v + \theta_i})$

EX2.1 Inductor L, $Z=j\omega L$, reactive power $Q=\omega L|I|^2$

$i(t)=\sqrt{2}|I|\cos(\omega t+\theta)$

$v(t)=L\,di/dt=-\sqrt{2}\omega L|I|\sin(\omega t+\theta)$

$$\begin{aligned} p(t)=v(t)*i(t)&=-2\omega L|I|^2\sin(\omega t+\theta)\cos(\omega t+\theta)\\ &=-\omega L|I|^2\sin2(\omega t+\theta) \end{aligned}$$

Average Power P=0,

瞬時功不為零(Instantaneous power is not zero)

$S=VI^*=ZII^*=Z|I|^2=j\omega L|I|^2=P+jQ$

所以$P=0, Q=\mathrm{Im}S=\omega L|I|^2$

練習1: Capacitor C,$Z=1/j\omega C$,reactive power $Q=-\omega C|V|^2$

$v(t)=\sqrt{2}|V|\cos(\omega t+\theta)$

$i(t)=C dv/dt=-\sqrt{2}\omega C|V|\sin(\omega t+\theta)$

$p(t)=v(t)*i(t)=-2\omega C|V|^2\sin(\omega t+\theta)\cos(\omega t+\theta)$

$=-\omega C|V|^2\sin 2(\omega t+\theta)$

Average Power P=0,

瞬時功不為零(Instantaneous power is not zero)

$S=VI^*=V(V/Z)^*=|V|^2/(Z)^*=-j\omega C|V|^2=P+jQ$

So $P=0,Q=\mathrm{Im}S=-\omega C|V|^2$

2.2複數功率守恆
(Conservation of Complex Power)

複數功率守恆($S_{in} = S_{out}$):數個頻率相同的獨立電源供應的網路，

由各個獨立電源供應的複數功率的總和會等於網路會等於網路上所有分支接收到的複數功率

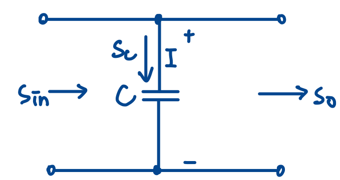
供電=用 電(Power of generators are equal Loads)

EX2.3輸入電源並聯電容C
Input voltage with shunt C

$S_{in}=S_c+S_o$

$S_c=VI^*=V(V/Z)^*=VV^*(1/Z)^*=VV^*(Y)^*=|V|^2(SC)^*$

$\quad=-j\omega C|V|^2$



$S_o=S_{in}-S_c=S_{in}+j\omega C|V|^2$

$P_o=P_{in}$

$Q_o=Q_{in}+\omega C|V|^2$

$C = 1000\,\mu F$

$.\ i = CSV,\quad V = \frac{i}{CS}$

$Z_c = \frac{1}{CS} = \frac{1}{1000 \times 10^{-6} \times j\omega}$

$\omega = 2\pi \times 60 = 377\ \text{rad/s}$

$Z_c = -j\,\frac{10^3}{377}$

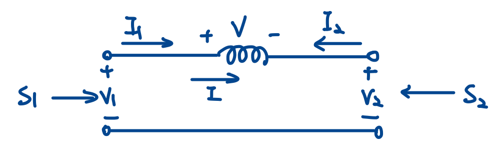
EX2.4輸入電源串聯電感L(假設$|V_2|=|V_1|$)

Series L between two voltage source

$S_1+S_2=S_L=VI^*=j\omega L|I|^2$

$P_1+P_2=0$

$Q_1+Q_2=Q_L=\omega L|I|^2$



$V = L\frac{di}{dt} = LsI = Lj\omega I$

$S_1=V_1I^*$

$S_2=-V_2I^*$

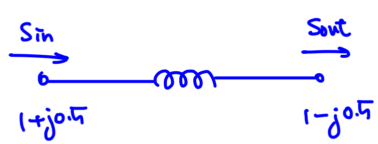
$\because |V_2|=|V_1| \Rightarrow |S_1|=|S_2| \Rightarrow (P_1)^2+(Q_1)^2=(P_2)^2+(Q_2)^2$

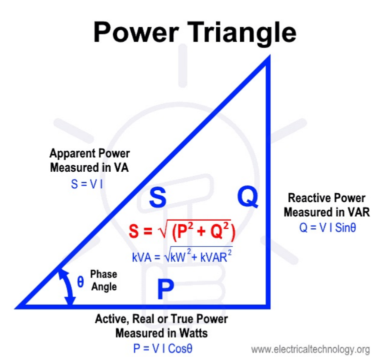
實功不受影响

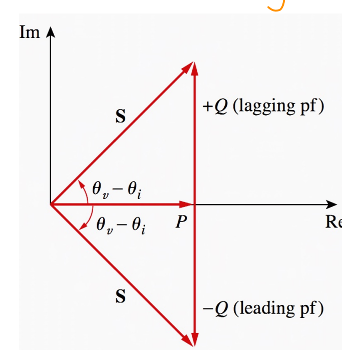
$\because |P_2|=|P_1| \Rightarrow |Q_2|=|Q_1| \Rightarrow Q_1=Q_2=0.5\omega L|I|^2$

$S = P + jQ$

So $P_1=-P_2$ ， $Q_1=Q_2 \Rightarrow S_2=-(S_1)^*$







EX2.5(假設$S_{ij} = -S^*_{ji}$) Find S_{13} , S_{31} , S_{23} , S_{32} and S_{G3} .

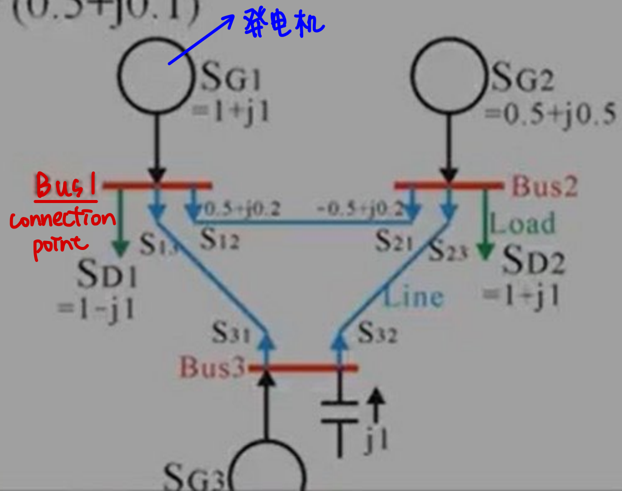
$S_{13} = (1+j1) - (1-j1) - (0.5+j0.2) = (-0.5+j1.8)$

$S_{31} = -S^*_{13} = (0.5+j1.8)$

$S_{23} = (0.5+j0.5) - (1+j1) - (-0.5+j0.2) = (-j0.7)$

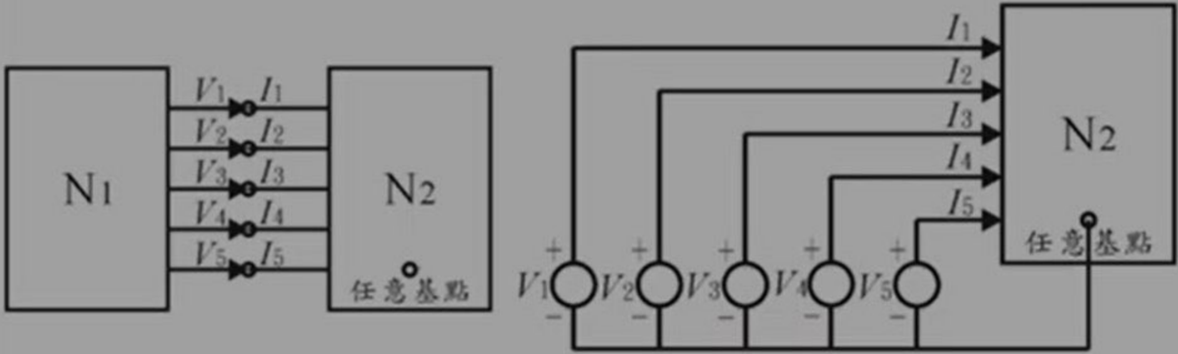
$S_{32} = -S^*_{23} = (-j0.7)$

$S_{G3} = (0.5+j1.8) - j0.7 - j1 = (0.5+j0.1)$



EX2.6 Find S from N_1 to N_2 .

$$S = (V_1 I^*_1 + V_2 I^*_2 + V_3 I^*_3 + V_4 I^*_4 + V_5 I^*_5)$$



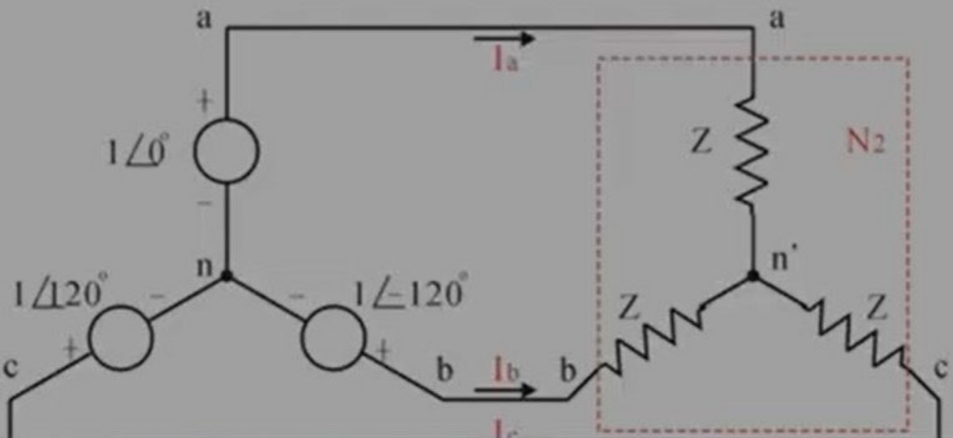
EX2.7三相電源(Three-phase voltages)

以n1為基點(n1 is basis point)

$S=V_{an1}I_a^*+V_{bn1}I_b^*+V_{cn1}I_c^*$(三瓦特計法)

以b為基點(b is basis point)

$S=V_{ab}I_a^*+V_{bb}I_b^*+V_{cb}I_c^*=V_{ab}I_a^*+V_{cb}I_c^*$(二瓦特計法)



EX2.7三相電源(Three-phase voltages)

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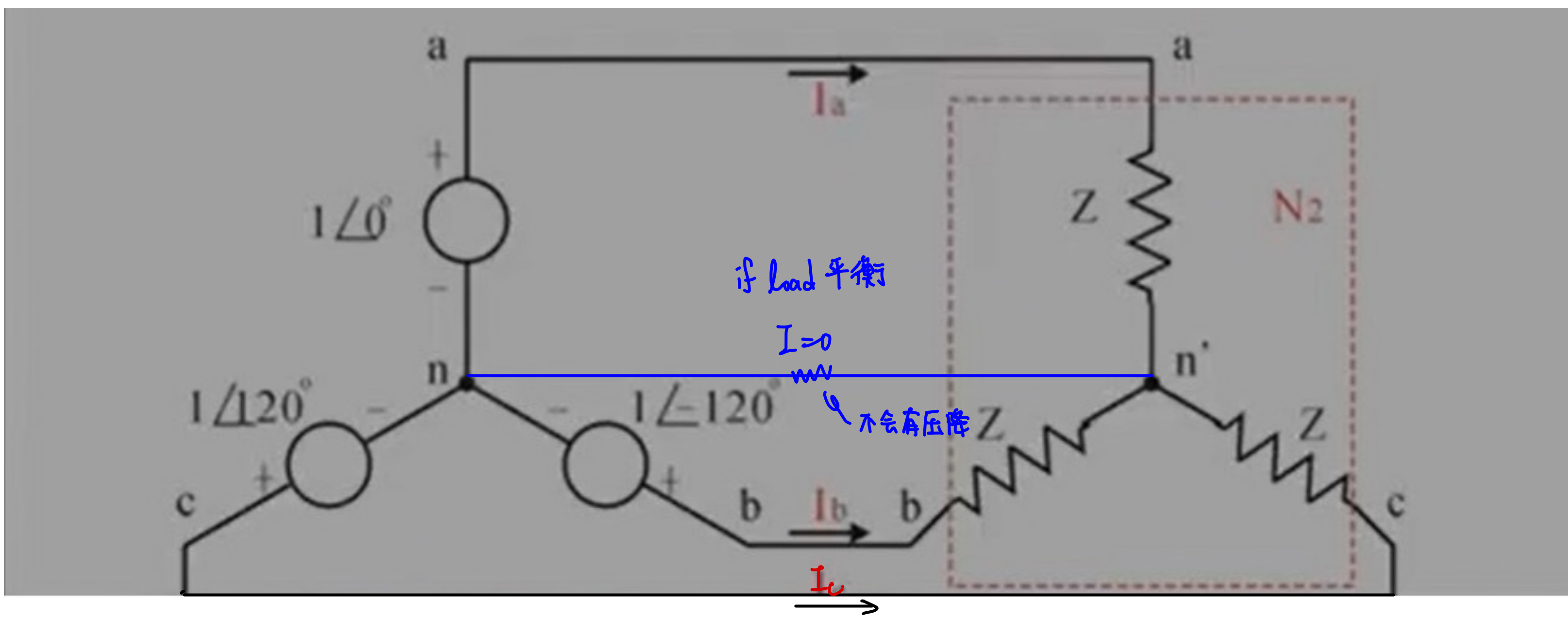
$S=V_{an1}I_a^*+V_{bn1}I_b^*+V_{cn1}I_c^*$(三瓦特計法)

以b為基點(b is basis point)

$S=V_{ab}I_a^*+V_{bb}I_b^*+V_{cb}I_c^*=V_{ab}I_a^*+V_{cb}I_c^*$(二瓦特計法)



☆ ① 平衡三相電壓 + 平衡三相負載

② 〃 〃 V三人R - - - + 不平衡三相負載

故障

③ 不平衡三相電壓（故障發生） + 平衡三相負載

④ - - - - - - + 不平衡三相負載

2.3平衡三相(Balanced Three-Phase)

pros：①无虚功　pros：①可升降压②传送距離遠

直流電與交流電的優缺點

cos：①无法升降压②传送距離短

Advantages and disadvantages of DC and AC voltages

pros：电力常数

單相交流電與三相交流電的優缺點

cons：①电力脉动

Advantages and disadvantages of single-phase voltage and three-phase voltages

$V_a(0^\circ) \rightarrow V_b(-120^\circ) \rightarrow V_c(-240^\circ)$　$V_a+V_b+V_c \neq 0$

正序與負序(產生旋轉磁場)，零序(故障.有DC)

$V_a(0^\circ) \rightarrow V_c(-240^\circ) \rightarrow V_b(-120^\circ)$

Positive sequence, negative sequence, zero sequence

电力电子

平衡與不平衡電壓和負載(線性與非線性負載)

Balanced and unbalanced voltages and loads

在発电机才是real中性点.其它的模了会飘

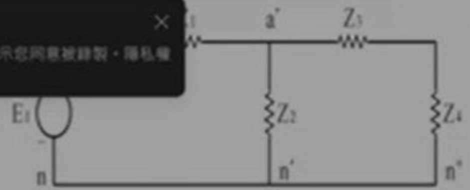
中性點電壓與電流(voltage and current of neutral point)

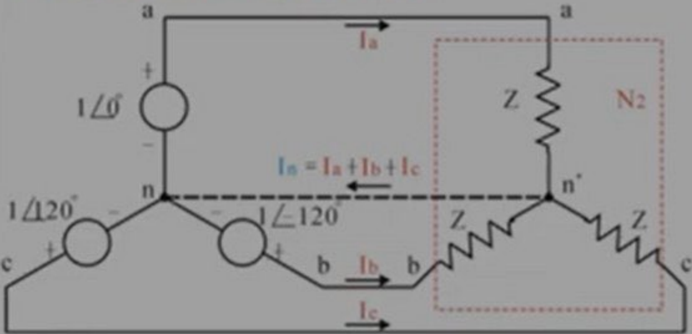
Δ-Y

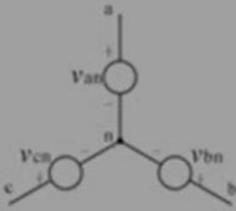
平衡三相(Balanced Three-P

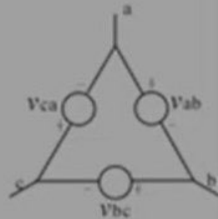
單相交流電 Single-phase v

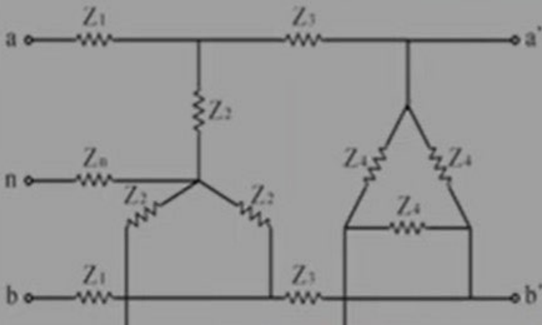
單相交流電,三相交流電

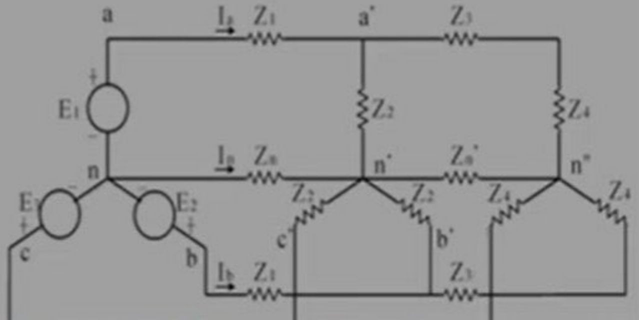












EX2.8三相電源與負載中性點電壓
Three-phase voltages and neutral point voltage

以n1為基點(n1 is basis point)

$I_a=V_{an1}/Z=(V_{an}-V_{n1n})/Z=(V_{an}-V_{n1n})Y$

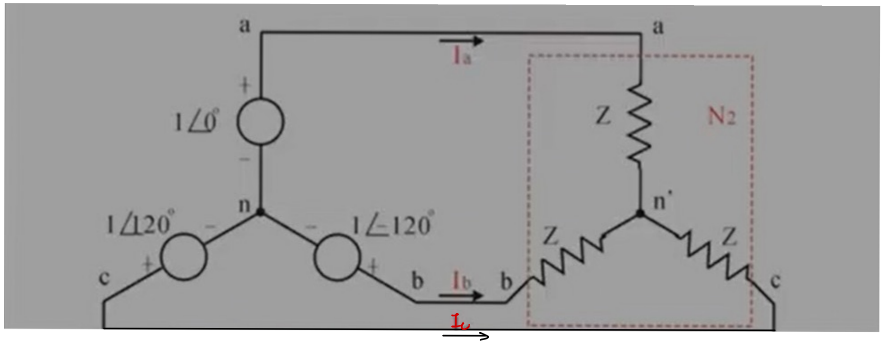
$I_b=V_{bn1}/Z=(V_{bn}-V_{n1n})/Z=(V_{bn}-V_{n1n})Y$

$I_c=V_{cn1}/Z=(V_{cn}-V_{n1n})/Z=(V_{cn}-V_{n1n})Y$

So $I_a+I_b+I_c=(V_{an}+V_{bn}+V_{cn})Y-3V_{n1n}Y=0$

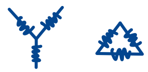
If $(V_{an}+V_{bn}+V_{cn})=0 \Rightarrow V_{n1n}=0$ theoretically, but not likely

EX2.9中性點阻抗不為零時?無妨



Δ-Y

阻抗(Impedance)

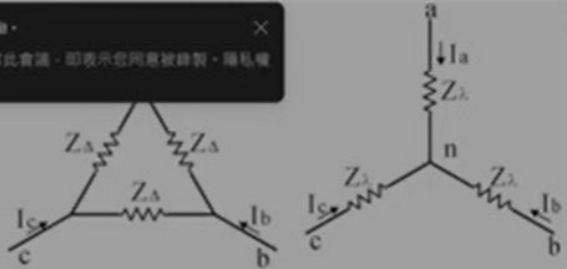
$Z_Y = Z_\Delta / 3$ 

EX2.10線對線電壓與相電壓?

Line-to-line voltages and Phase voltages?

Δ-Y

錄製已啟動。
一旦出席此會議，即表示您同意被錄製，隱私權原則



阻抗(Impedance) $Z_Y = Z_\Delta / 3$

(2.13) for $\Delta : I_a = (V_{ab} / Z_\Delta) + (V_{ac} / Z_\Delta)$

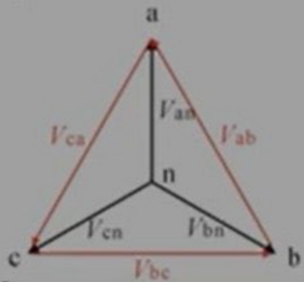
For Y: $V_{ab} = V_{an} - V_{bn} = Z_Y I_a - Z_Y I_b$

For Y: $V_{ac} = V_{an} - V_{cn} = Z_Y I_a - Z_Y I_c$

$\Rightarrow V_{ab} + V_{ac} = Z_Y (2I_a - I_b - I_c)$

For n: $I_a + I_b + I_c = 0$, => $V_{ab} + V_{ac} = 3Z_Y I_a$ (2.14)

From (2.13) and (2.14) $Z_Y = Z_\Delta / 3$



EX2.10線對線電壓與相電壓?

Line-to-line voltages and Phase voltages?

(2.15) $V_{ab} = V_{an} - V_{bn}$, $V_{bc} = V_{bn} - V_{cn}$, $V_{ca} = V_{cn} - V_{an}$

a→b→c

Positive Sequence: $V_{bn} = V_{an} \exp(-j2\pi/3)$, $V_{cn} = V_{an} \exp(j2\pi/3)$,

(2.16) $V_{ab} = V_{an} - V_{bn} = [1 - \exp(-j2\pi/3)]V_{an} = (\sqrt{3}) \exp(j\pi/6) V_{an}$,

(2.17) $V_{an} = (1/\sqrt{3}) \exp(-j\pi/6) V_{ab}$,

a→c→b

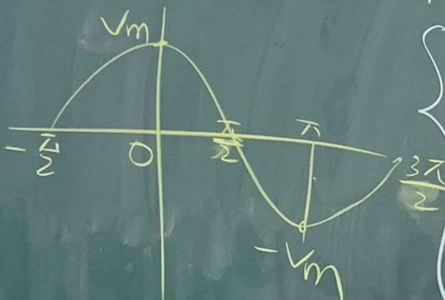
Negative Sequence: $V_{bn} = V_{an} \exp(j2\pi/3)$, $V_{cn} = V_{an} \exp(-j2\pi/3)$,

單相 110 Vrms / 60 Hz

$$v(t) = \sqrt{2}\times 110 \sin 377t$$

$$或 = \sqrt{2}\times 110 \cos 377t$$

$$或 = V_m \cos \omega t, \quad \omega = 2\pi f = 120\pi\ \frac{rad}{sec}$$



三相 220 Vrms / 60Hz

L-L 線對線

找不到中性桌

$$V_a(t) = 180 \cos \omega t$$

$$V_b(t) = 180 \cos(\omega t - 120^\circ)$$

$$V_c(t) = 180 \cos(\omega t - 240^\circ)$$

$$V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{180}{\sqrt{2}} = 127$$

$v_{ab} = 310\cos(\omega t + 30^\circ)$ $220 \times \sqrt{2}$

$V_{bc} = 310\cos(\omega t + 30^\circ - 120^\circ)$

$V_{ca} = 310\cos(\omega t + 30^\circ - 240^\circ)$

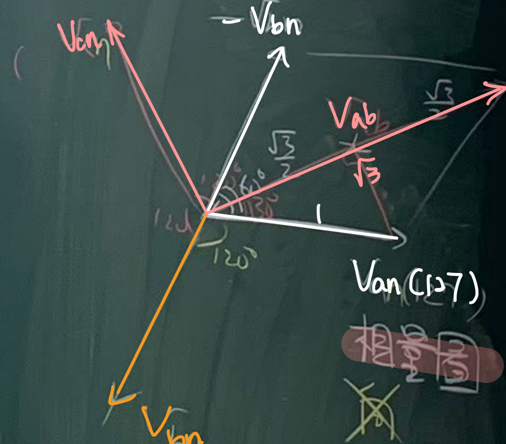
$\omega = 2\pi f = 120\pi\ \mathrm{rad/sec}$

rms / 60Hz

$\omega t - 120^\circ)$

$\omega t - 240^\circ)$

$V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{180}{\sqrt{2}} = 127$



相量圖

$V_{ab} = V_{an} - V_{bn}$

$= \sqrt{3}\,V_{an}\angle 30^\circ$

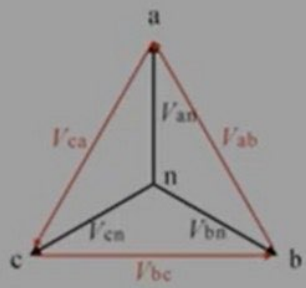
$= 220 \angle 30^\circ\ (V_{rms})$

EX2.10 Balanced positive sequence line-to-line voltage, $V_{ab} = 1\angle 0^\circ$, find V_{an}, V_{bn}, and V_{cn}.

$V_{an} = (1/\sqrt{3})\angle -30^\circ$,

$V_{bn} = (1/\sqrt{3})\angle -150^\circ$,

$V_{cn} = (1/\sqrt{3})\angle 90^\circ$,



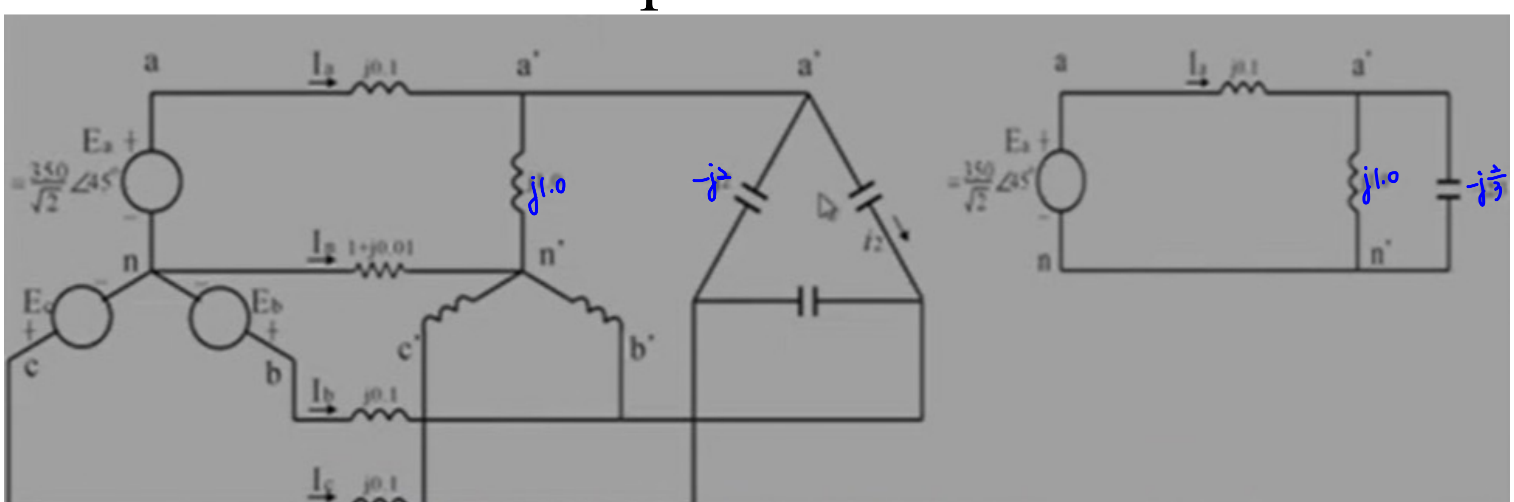
2.4單相分析(平衡三相)Per Phase Analysis

平衡三相(Balanced three-phase)

假設:平衡三相系統；負載與電源是星形連接；電路模型中，相之間無互感存在

所以:所有的中性點電位相同；各相是完全去耦合；所有對應的網路變數和平衡電源系統具有相同相序

EX2.11 Balanced three-phase?



2.5平衡三相功率(瞬時功率為常數)

Power of the balanced three-phase is constant

$S_3=V_aI_a^*+V_bI_b^*+V_cI_c^*$

Balanced three-phase and positive sequency

$S_3=V_aI_a^*+V_ae^{-j2\pi/3}(I_ae^{-j2\pi/3})^*+V_ae^{j2\pi/3}(I_ae^{j2\pi/3})^*=3V_aI_a^*$

Instantaneous Power: $\overset{\text{constant}}{\boxed{p_3(t)}}=\overset{\text{脈动}}{\boxed{p_a(t)}}+p_b(t)+p_c(t)$

$p_3(t)=v_a(t)i_a(t)+v_b(t)i_b(t)+v_c(t)i_c(t)$

$v_a(t)*i_a(t)=V_m\cos(\omega t+\theta_v)*I_m\cos(\omega t+\theta_i)$

$=0.5*V_mI_m[\cos(\theta_v-\theta_i)+\cos(2\omega t+\theta_v+\theta_i)]$

$v_b(t)*i_b(t)=V_m\cos(\omega t+\theta_v-2\pi/3)*I_m\cos(\omega t+\theta_i-2\pi/3)$

$=0.5*V_mI_m[\cos(\theta_v-\theta_i)+\cos(2\omega t+\theta_v+\theta_i-4\pi/3)]$

$v_c(t)*i_c(t)=V_m\cos(\omega t+\theta_v+2\pi/3)*I_m\cos(\omega t+\theta_i+2\pi/3)$

$=0.5*V_mI_m[\cos(\theta_v-\theta_i)+\cos(2\omega t+\theta_v+\theta_i+4\pi/3)]$

$p_3(t)=3*0.5*V_mI_m[\cos(\theta_v-\theta_i)]=3|V||I|\cos(\theta_v-\theta_i)$

2.6複數功率傳輸(短程)Complex power Transmission

< 100km

短程輸電線，用串聯的RL電路來表示電線$Z=R+j\omega L$

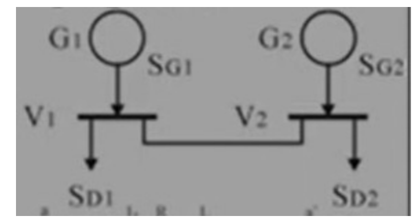
$V_1=|V_1|e^{j\theta 1}$，$V_2=|V_2|e^{j\theta 2}$，$Z=|Z|\ e^{j\angle Z}$，$\theta_{12}=\theta_1-\theta_2$

$S_{12}=V_1 I_1^*=V_1[(V_1-V_2)/Z]^*=|V_1|^2/(Z)^*-V_1 V_2^*/(Z)^*$

90° 90°

$=|V_1|^2\ e^{j\angle Z}/|Z|-|V_1||V_2|\ e^{j\angle Z}e^{j\theta 12}/|Z|$

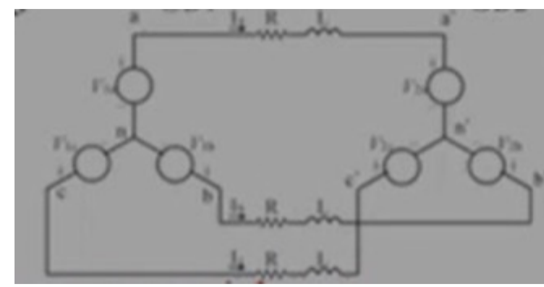
imaginary



$S_{21}=|V_2|^2\ e^{j\angle Z}/|Z|-|V_1||V_2|\ e^{j\angle Z}e^{-j\theta 12}/|Z|$

Assume R=0，$Z=jX \Rightarrow \angle Z=90°$，$e^{j\angle Z}=j$

So $P_{12}=-P_{21}=(|V_1||V_2|/X)\sin\theta_{12}$



$Q_{12}=|V_1|^2/X-(|V_1||V_2|/X)\cos\theta_{12}$

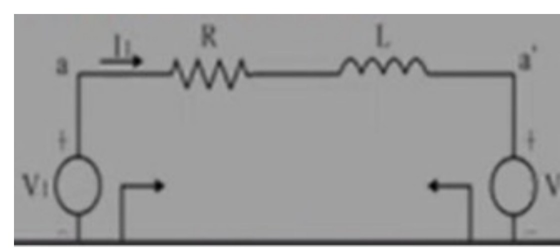
由中間的Z造成的差異

$Q_{21}=|V_2|^2/X-(|V_1||V_2|/X)\cos\theta_{12}$

EX2.12兩個發電機失去同步? Two generators without synchronous?

弦波式擾动 ⇒ explode

$P_{12}=-P_{21}=(|V_1||V_2|/X)\sin[(\omega_1-\omega_2)t+\theta_{12}]$



AC

② 負載增加 ⇒ 電壓下降 + 頻率下降

且

兩台發電机.

SG1 

 SG_2

同頻率
同電壓
同角度

可以微調

$L = 1mH$

$LS = jL\omega = jX$

$X = L\omega$

$= 1\times10^{-3}\times377$

$= 0.377H$

功率圓(短程) Complex power Circle

短程輸電線，用串聯的RL電路來表示電線$Z=R+j\omega L$

(2.25) $V_1=|V_1|e^{j\theta 1}$，$V_2=|V_2|e^{j\theta 2}$，$Z=|Z|\ e^{j\angle Z}$，$\theta_{12}=\theta_1-\theta_2$

(2.26) $S_{12}=V_1I_1^*=V_1[(V_1-V_2)/Z]^*=|V_1|^2/(Z)^*-V_1V_2^*/(Z)^*$

$=|V_1|^2\ e^{j\angle Z}/|Z|-|V_1||V_2|\ e^{j\angle Z}e^{j\theta 12}/|Z|$

draw a circle

(2.27) $S_{21}=|V_2|^2\ e^{j\angle Z}/|Z|-|V_1||V_2|\ e^{j\angle Z}e^{-j\theta 12}/|Z|$

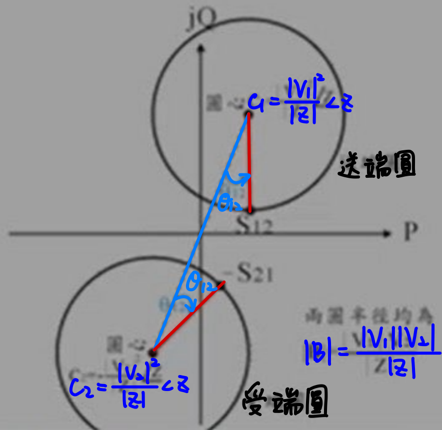
(2.28) $-S_{21}=-|V_2|^2\ e^{j\angle Z}/|Z|+|V_1||V_2|\ e^{j\angle Z}e^{-j\theta 12}/|Z|$

(2.29) $S_{12}=C_1-B\,e^{j\theta 12}$,

(2.30) $-S_{21}=C_2+B\,e^{-j\theta 12}$,

$C_1=|V_1|^2\ e^{j\angle Z}/|Z|$, $C_2=-|V_2|^2\ e^{j\angle Z}/|Z|$,

$B=|V_1||V_2|\ e^{j\angle Z}/|Z|$.



Assume $R=0$，$Z=jX \Rightarrow \angle Z=90^\circ$，$e^{j\angle Z}=j$

So (2.31) $P_{12}=-P_{21}=(|V_1||V_2|/X)\sin\theta_{12}$

(2.32) $Q_{12}=|V_1|^2/X-(|V_1||V_2|/X)\cos\theta_{12}$

(2.33) $Q_{21}=|V_2|^2/X-(|V_1||V_2|/X)\cos\theta_{12}$

EX2.13(短程 short distance) $Z=1\angle 85^\circ$，$\theta_{12}=10^\circ$

⇒有R

(R=0. ∠Z=90°)

(a) $|V_1|=|V_2|=1$

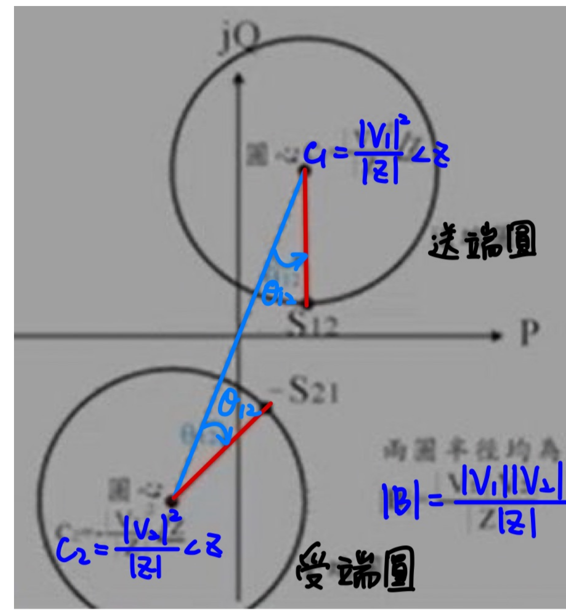
$S_{12}=V_1I_1^*=V_1[(V_1-V_2)/Z]^*=|V_1|^2/(Z)^*-V_1V_2^*/(Z)^*$

$=|V_1|^2 e^{j\angle Z}/|Z|-|V_1||V_2| e^{j\angle Z}e^{j\theta_{12}}/|Z|$

$S_{12}=1\angle 85^\circ-1\angle 95^\circ$

$S_{21}=|V_2|^2 e^{j\angle Z}/|Z|-|V_1||V_2| e^{j\angle Z}e^{-j\theta_{12}}/|Z|$

$S_{21}=1\angle 85^\circ-1\angle 75^\circ$



$P_{12}=-P_{21}=0.1743$

$Q_{12}=0$ (巧合)

$Q_{21}=0.0303$

(b) $|V_1|=1.1$，$|V_2|=0.9$，$Z=1\angle 85^\circ$，$\theta_{12}=10^\circ$

EX2.14 S_{G1}:$V_1=1\angle 0°$，$S_{D1}=1$，jQ_{G2} :$V_2=?$ ，$S_{D2}=1$，$Z=j0.5$

(a)Find Q_{G2} for $|V_2|=1$ (b) and $\angle V_2$?(c)If $Q_{G2}=0$,could be supplied load S_{D2} ?(d) and $\angle V_2$?

$\because$ $S_{D2}=1$ real，and jQ_{G2} imaginary number，So $P_{12}= -P_{21}=1$

So $P_{12}= -P_{21}=(|V_1||V_2|/X)\sin\theta_{12}=2\sin\theta_{12}=1$

So $\theta_{12}=30°$ ，and $\angle V_2=-30°$ $\theta_{12}=30°.$ $\theta_1=0° \Rightarrow \theta_2=-30°$

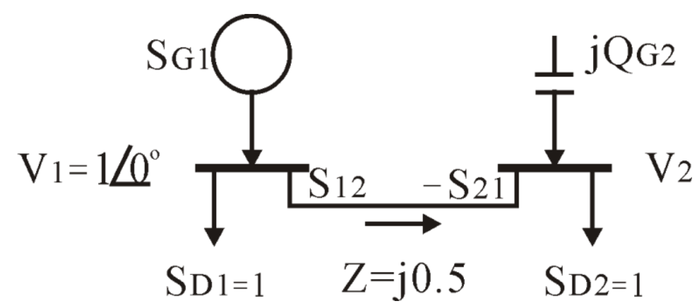
$Q_{G2}=Q_{21}=|V_2|^2/X - (|V_1||V_2|/X)\cos\theta_{12}=2-2\cos 30°=0.268$

(c) and (d)

If $Q_{G2}=0$,$-S_{21}= S_{D2}=1$

$S_{21}=|V_2|^2 e^{j\angle Z}/|Z|-|V_1||V_2| e^{j\angle Z}e^{-j\theta 12}/|Z|=-1$

Find $2|V_2|^2=1$,$\theta_{12}=45°$ => $V_2=0.707\angle -45°$



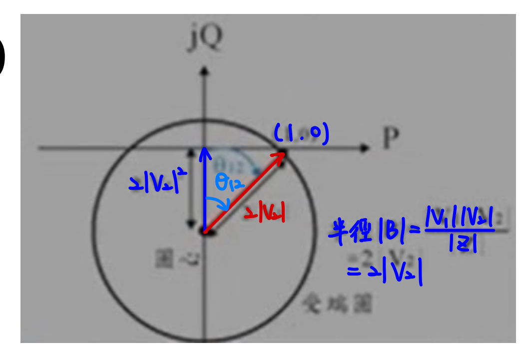
(c) and (d)

If $Q_{G2}=0$,so $Q_{G2}=Q_{21}=|V_2|^2/X - (|V_1||V_2|/X)\cos\theta_{12}=0$

so $|V_2|=|V_1|\cos\theta_{12}= \cos\theta_{12}$

If $P_{12}= -P_{21}=(|V_1||V_2|/X)\sin\theta_{12}=2|V_2|\sin\theta_{12}=1$

so $\theta_{12}=45°$,$|V_2|=0.707$



2.7複數功率傳輸(輻射線路)
Complex Power Transmission: Radial Line

較遠的一端有複數功率負載，沒有發電機或電容器組來維持電壓，求遠端電壓受負載變化的影響?

$S_D = V_2 I^* = |V_2||I|e^{j\psi}$　　$PF = \cos\phi$

$= |V_2||I|(\cos\psi + j\sin\psi) = P_D(1+j\beta)$　$\beta = \tan\phi$　，$\phi = \angle V_2 - \angle I$

$P_D = P_{12} = -P_{21} = (|V_1||V_2|/X)\sin\theta_{12}$

$Q_D = -Q_{21} = -|V_2|^2/X + (|V_1||V_2|/X)\cos\theta_{12}$

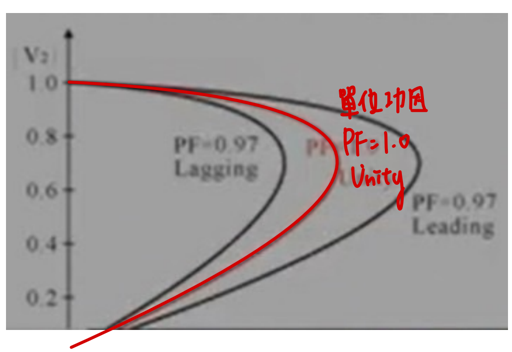
$(\cos\theta_{12})^2 + (\sin\theta_{12})^2 = 1$,

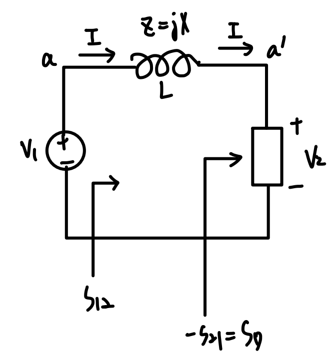
(2.37) $(\beta P_D + |V_2|^2/X)^2 = (|V_1||V_2|/X)^2 - (P_D)^2$,

(2.38) $|V_2|^4 + (2\beta P_D X - |V_1|^2)|V_2|^2 + (1+\beta^2)(P_D X)^2 = 0$, So

(2.39) $|V_2|^2 = (|V_1|^2/2) - (\beta P_D X) \pm [(|V_1|^4/4) - P_D X(P_D X + \beta|V_1|^2)]^{0.5}$,

So $|V_2|^2 = (1/2)(1 - \beta P_D \pm [1 - P_D(P_D + 2\beta)]^{0.5})$





DC

① 短路

② 負載增加

⇒電壓下降

兩台發電机

2.8結論與習題(Summary)

瞬時功率(Instantaneous Power)

複數功率(Complex Power)

有效功率(Real Power)

無效功率(Reactive Power)

相量(Phasor)

平衡三相(Balanced Three-Phase)

單相分析(Per Phase Analysis)