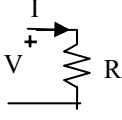
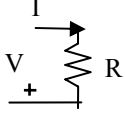


GUC

Devrelerde gerilimin + ucundan akim girecek sekilde yon tanimi yapilmalidir.

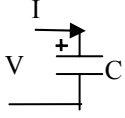


Yon bu sekilde tanimlanirsa $V=RI$ olur.

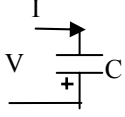


Yon bu sekilde tanimlanirsa $V = -RI$ olur.

Bunun gibi kapasite taniminda de



$I = C \frac{dV}{dt}$ seklinde dir. Eger akim gerilimin + ucundan girmez ise yani sekildeki gibi olursa

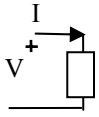


$$I = -C \frac{dV}{dt}$$

sekinde tanim yapilir.

----- GUC -----

Bundan sonra aksi soylene medikce gerilimin +ucundan akim girer varsayimi yapilacaktir.

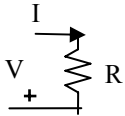


Elektrik devresinde elemanin gucu $P=V I$ dir.

Eger P pozitif ise eleman **guc tuketir**.

Eger P negatif ise eleman guc uredir.

151) $V=10V$, $R=4\Omega$ ise devrenin gucunu inceleyin.

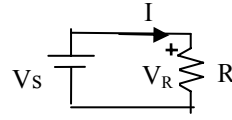


$$I=V/R=10/4=2.5A,$$

$$P=V I=10 \cdot 2.5=25W$$

Guc pozitif oldugundan devre guc harcar.

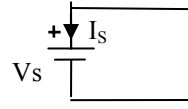
152) $V_s=10V$, $R=4\Omega$ ise devrenin gucunu inceleyin.



$$I=V_R/R=V_s/R=10/4=2.5A,$$

$$P_R=V_R I=10 \cdot 2.5=25W$$

V_s kaynagi icin

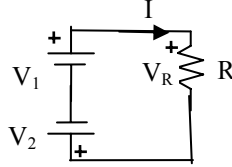


$$P_s=V_s I_s=V_s (-I)=10 (-2.5)=-25W$$

P_R pozitif oldugundan direnc guc harcar.

P_s negatif oldugundan kaynak guc uredir.

153) $V_1=20V$, $V_2=10V$, $R=2\Omega$ ise devre elemanlarinin gucunu inceleyin.



$$V_2-V_1+RI=0, \quad I=(20-10)/2=5A$$

$$P_1=V_1 I_1=V_1 (-I)=20 \cdot 5=-100W$$

$$P_2=V_2 I_2=V_2 I=10 \cdot 5=50W$$

$$V_R=R I=2 \cdot 5=10V$$

$$P_R=V_R I_R=V_R I=10 \cdot 5=50W$$

P_1 : guc uredir.

P_2 : guc tuketir.

P_R : guc tuketir.

Bir devrede uredilen ve harcanan guc birbirine esittir. esittir.

uredilen guc=harcanan guc

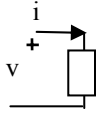
matematiksel olarak uredilen guc negatif harcanan guc pozitif oldugundan.

$$\sum_{i=1}^n P_i = 0$$

olarak ifade edilir.

Alternatif akimda guc.

211)Devredeki gucleri hesaplayin.



$$v = V_m \cos(\omega t + \theta_v),$$

$$i = I_m \cos(\omega t + \theta_i),$$

$$v = V_m \cos(\omega t + \theta_v - \theta_i),$$

$$i = I_m \cos \omega t.$$

Ani Guc

$$p = V_m I_m \cos(\omega t + \theta_v - \theta_i) \cos \omega t.$$

$$\cos \alpha \cos \beta = \frac{1}{2} \cos(\alpha - \beta) + \frac{1}{2} \cos(\alpha + \beta)$$

Yerine yerlestirelim.

$$p = \frac{V_m I_m}{2} \cos(\theta_v - \theta_i) + \frac{V_m I_m}{2} \cos(2\omega t + \theta_v - \theta_i).$$

$\cos(2\omega t + \dots)$ terimini acalim.

$$\cos(\alpha + \beta) = \cos \alpha \cos \beta - \sin \alpha \sin \beta$$

$$p = \frac{V_m I_m}{2} \cos(\theta_v - \theta_i) + \frac{V_m I_m}{2} \cos(\theta_v - \theta_i) \cos 2\omega t$$

$$- \frac{V_m I_m}{2} \sin(\theta_v - \theta_i) \sin 2\omega t.$$

$$P = \frac{V_m I_m}{2} \cos(\theta_v - \theta_i),$$

$$Q = \frac{V_m I_m}{2} \sin(\theta_v - \theta_i).$$

$$p = P + P \cos 2\omega t - Q \sin 2\omega t,$$

P:Ortalama guc (Average power)

Q:reaktif guc (Reaktif power)

$\cos(\theta_v - \theta_i)$: Guc faktoru

$\sin(\theta_v - \theta_i)$: reaktif guc faktoru

$$P = \frac{1}{T} \int_{t_0}^{t_0+T} p dt,$$

Guc faktorunu sadece kosinus cinsinden verilmesi yeterli degildir isaretinin de verilmesi gerekir.

Mesela a) $\theta_v=80$, $\theta_i=20$, b) $\theta_v=20$, $\theta_i=80$

durumlari icin guc faktorunu hesaplayalim.

a) $\cos(\theta_v - \theta_i) = \cos(80-20)=0.5$

b) $\cos(\theta_v - \theta_i) = \cos(20-80)=0.5$

Her iki durumda da guc faktoru 0.5 bunu ayirmak icin

$\theta_v > \theta_i$, veya $\theta_v - \theta_i > 0$ ise geri fazli

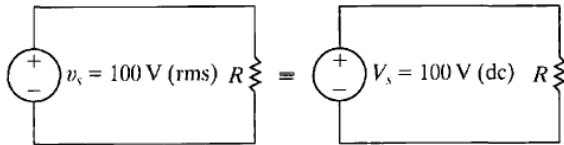
$\theta_v < \theta_i$, veya $\theta_v - \theta_i < 0$ ise ileri fazli deyimleri kullanilir.

a)0.5 geri fazli, b)0.5 ileri fazli olarak kullanilir.

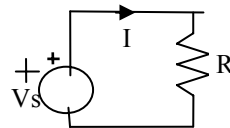
Efektif Deger Cinsinden

$$\begin{aligned} P &= \frac{V_m I_m}{2} \cos(\theta_v - \theta_i) \\ &= \frac{V_m}{\sqrt{2}} \frac{I_m}{\sqrt{2}} \cos(\theta_v - \theta_i) \\ &= V_{\text{eff}} I_{\text{eff}} \cos(\theta_v - \theta_i); \end{aligned}$$

$$Q = V_{\text{eff}} I_{\text{eff}} \sin(\theta_v - \theta_i).$$



351) $v=20\cos(8t+30)$, $R=10\Omega$ ise R direncinde harcanan a) ortalama gucu, b)reaktif gucu c)ani gucu, hesaplayin.



a)Devrede

$$v=20\cos(8t+30) = V_m \cos(\omega t + \theta_v)$$

$$V_m=20, \quad \omega=8, \quad \theta_v=30$$

$$i = V_s/R = 20\cos(8t+30)/10 = 2\cos(8t+30)$$

$$= I_m \cos(\omega t + \theta_i)$$

$$I_m=2, \quad \omega=8, \quad \theta_i=30$$

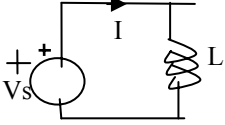
$$a) P = \frac{V_m I_m}{2} \cos(\theta_v - \theta_i) = \frac{20}{2} \frac{2}{2} \cos(30-30) = 40$$

$$b) Q = \frac{V_m I_m}{2} \sin(\theta_v - \theta_i) = \frac{20}{2} \frac{2}{2} \sin(30-30) = 0$$

$$c) p = P + P \cos 2\omega t - Q \sin 2\omega t \\ = 40 + 40 \cos 16t$$

Dirende harcanan reaktif guc sifirdir.

353) $v=20\cos(5t+30)$, $L=2H$ ise L de harcanan a) ortalama gucu, b) reaktif gucu c) ani gucu, hesaplayin.

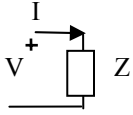


a) Devrede

$$v=20\cos(5t+30) = V_m \cos(\omega t + \theta_v)$$

$$V_m=20, \omega=5, \theta_v=30$$

gecen akimi bulmamiz lazim.

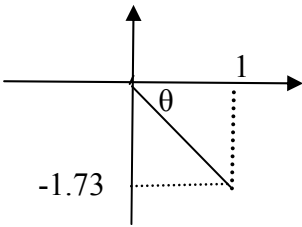


$$v=20\cos(5t+30) \Rightarrow V=20 \angle 30, V=20 e^{j30}, \\ Z=j\omega L=j5 \cdot 2=10j$$

$$I = V/Z = 20 e^{j30}/10j$$

$$I = \frac{20(\cos 30 + j \sin 30)}{10j} = -2j(0.866 + 0.5j)$$

$$I = 1 - 1.73j = \sqrt{1^2 + 1.73^2} e^{j\theta}, \theta = \arctan\left(\frac{-1.73}{1}\right) = -60$$



$$I = 2 e^{-j60} = 2 \angle -60 \Rightarrow i = 2 \cos(5t-60)$$

$$I_m=2, \omega=5, \theta_i=-60$$

$$V_m=20, \omega=5, \theta_v=30$$

$$a) P = \frac{V_m I_m}{2} \cos(\theta_v - \theta_i) = \frac{20}{2} \frac{2}{2} \cos(30-(-60))$$

$$= 20 \cos 90 = 0$$

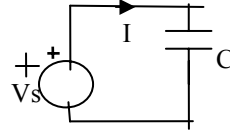
$$b) Q = \frac{V_m I_m}{2} \sin(\theta_v - \theta_i) = \frac{20}{2} \frac{2}{2} \sin(30-(-60))$$

$$= 20 \sin 90 = 20$$

$$c) p = -Q \sin \omega t = -20 \sin 10t$$

Enduktansda (bobinde) harcanan ortalama guc sifirdir.

355) $v=20\cos(5t+30)$, $C=0.02F$ ise C de harcanan a) ortalama gucu, b) reaktif gucu c) ani gucu, hesaplayin.



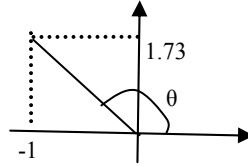
Yukaridaki islemler tekrarlanirsa

$$Z = 1/j\omega C = 1/(j5 \cdot 0.02) = -10j$$

$$I = V/Z = 20 e^{j30}/(-10j)$$

$$I = \frac{20(\cos 30 + j \sin 30)}{-10j} = 2j(0.866 + 0.5j)$$

$$I = -1 + 1.73j = \sqrt{1^2 + 1.73^2} e^{j\theta}, \theta = \arctan\left(\frac{1.73}{-1}\right) = 120$$



$$I = 2 e^{j120} = 2 \angle 120 \Rightarrow i = 2 \cos(5t+120)$$

$$I_m=2, \omega=5, \theta_i=120$$

$$V_m=20, \omega=5, \theta_v=30$$

$$a) P = \frac{V_m I_m}{2} \cos(\theta_v - \theta_i) = \frac{20}{2} \frac{2}{2} \cos(30-120)$$

$$= 20 \cos (-90) = 0$$

$$b) Q = \frac{V_m I_m}{2} \sin(\theta_v - \theta_i) = \frac{20}{2} \frac{2}{2} \sin(30-120)$$

$$= 20 \sin (-90) = -20$$

$$c) p = -Q \sin 2\omega t = 20 \sin 10t$$

kondansatorde harcanan ortalama guc sifirdir.

Dirende harcanan reaktif guc sifirdir.

Enduktansda (bobinde) harcanan ortalama guc sifirdir

kondansatorda harcanan ortalama guc sifirdir.

P: Ortalama guc: gercek harcanan guctur.

Ortalama guc=0 demek o eleman gercekte guc harcamiyor demektir.

Bobin ve kondansatorda guc harcanmaz. Direncde guc harcanir. Direnc elektrik enerjisini isi enerjisine donusturur. Etrafa isi (enerji) dagitir. Bobin ve kondansator elektrik enerjisini isi enerjisine donusturmezler etrafa enerji yaymazlar.

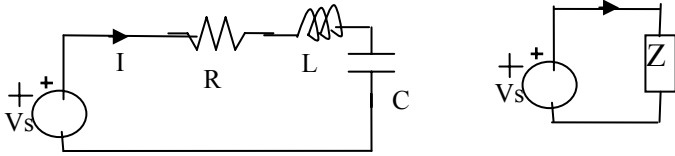
Q: Reaktif guc: Bir cesit sanal guc olarak dusunebiliriz. elektrik kaynagi ile bobin(veya kapasite) arasinda gidip gelen guctur.

Bobinde reaktif guc pozitif, kapasitede negatiftir.

P watt ile olcultur. Q VAR ile olcultur.

(VAR: VOLTAMPER)

361) $v=20\cos(5t+30)$, $R=2\Omega$, $L=2H$, $C=0.04F$ ise R,L,C de toplam harcanan a) ortalama gucu, b) reaktif gucu c) ani gucu, hesaplayin. d) Guç faktorunu ve reaktif guç faktorunu hesaplayin



$$Z = R + j\omega L + 1/j\omega C = 2 + j5 + 1/(j5 \cdot 0.04)$$

$$= 2 + 10j - 5j = 2 + 5j$$

$$I = V/Z = 20 e^{j30}/(2+5j) = 2.9 - 2.3j$$

$$I = 3.7 e^{-j38.2} \implies i = 3.7 \cos(5t - 38.2)$$

$$I_m = 3.7, \quad \omega = 5, \quad \theta_i = -38.2$$

$$V_m = 20, \quad \omega = 5, \quad \theta_v = 30$$

$$a) \quad P = \frac{V_m I_m}{2} \cos(\theta_v - \theta_i) = 0.5 \cdot 20 \cdot 3.7 \cos(30 + 38.2) = 13.7$$

$$b) \quad Q = \frac{V_m I_m}{2} \sin(\theta_v - \theta_i) = \frac{20 \cdot 2}{2} \sin(30 - 120) = 34.48$$

$$c) \quad p = P + P \cos 2\omega t - Q \sin 2\omega t$$

$$= 13.7 + 13.7 \cos 10t - 34.48 \sin 10t$$

$$d) \quad \text{Guc faktoru} = \cos(\theta_v - \theta_i) = \cos(68.2) = 0.37$$

$$\text{reaktif Guç faktoru} = \sin(\theta_v - \theta_i) = \sin(68.2) = 0.93$$

363) Yukaridaki soru icin $v=20\cos(5t+30)$, $R=2\Omega$, $L=2H$, $C=0.02F$ ise R,L,C de toplam harcanan a) ortalama gucu, b) reaktif gucu c) ani gucu, hesaplayin. d) Guç faktorunu ve reaktif guç faktorunu hesaplayin

$$\text{Cozum} \quad Z = R + j\omega L + 1/j\omega C = 2 + j5 + 1/(j5 \cdot 0.02)$$

$$= 2 + 10j - 10j = 2$$

$$I = V/Z = 20 e^{j30}/(2) = 10 e^{j30}$$

$$I_m = 10, \quad \omega = 5, \quad \theta_i = 30$$

$$V_m = 20, \quad \omega = 5, \quad \theta_v = 30$$

$$a) \quad P = \frac{V_m I_m}{2} \cos(\theta_v - \theta_i) = 0.5 \cdot 20 \cdot 10 \cos(30 - 30) = 100$$

$$b) \quad Q = \frac{V_m I_m}{2} \sin(\theta_v - \theta_i) = \frac{20 \cdot 10}{2} \sin(30 - 30) = 0$$

$$c) \quad p = P + P \cos 2\omega t - Q \sin 2\omega t$$

$$= 100 + 100 \cos 10t$$

Komplex GUC

$$S = P + jQ.$$

$$P = |S| \cos \theta,$$

$$Q = |S| \sin \theta.$$

$$\theta = \theta_v - \theta_i$$

$$S = \frac{V_m I_m}{2} \cos(\theta_v - \theta_i) + j \frac{V_m I_m}{2} \sin(\theta_v - \theta_i)$$

$$= \frac{V_m I_m}{2} [\cos(\theta_v - \theta_i) + j \sin(\theta_v - \theta_i)]$$

$$= \frac{V_m I_m}{2} e^{j(\theta_v - \theta_i)} = \frac{1}{2} V_m I_m \angle (\theta_v - \theta_i).$$

$$S = V_{\text{eff}} I_{\text{eff}} \angle (\theta_v - \theta_i).$$

$$S = V_{\text{eff}} I_{\text{eff}} \angle (\theta_v - \theta_i)$$

$$= V_{\text{eff}} I_{\text{eff}} e^{j(\theta_v - \theta_i)}$$

$$= V_{\text{eff}} e^{j\theta_v} I_{\text{eff}} e^{-j\theta_i}$$

$$= \mathbf{V}_{\text{eff}} \mathbf{I}_{\text{eff}}^*$$

$$S = \frac{1}{2} \mathbf{V} \mathbf{I}^*.$$

Burada $\mathbf{V}_{\text{eff}} = V_{\text{eff}} e^{j\theta}$, $\mathbf{I}_{\text{eff}} = I_{\text{eff}} e^{j\theta}$, tanımları vardır.

Örnek: V ve I aşağıdaki gibidir. P ve Q'yu hesaplayın.

$$\mathbf{V} = 100 \angle 15^\circ \text{ V},$$

$$\mathbf{I} = 4 \angle -105^\circ \text{ A}.$$

$$S = \frac{1}{2} (100 \angle 15^\circ) (4 \angle +105^\circ) = 200 \angle 120^\circ$$

$$= -100 + j173.21 \text{ VA}.$$

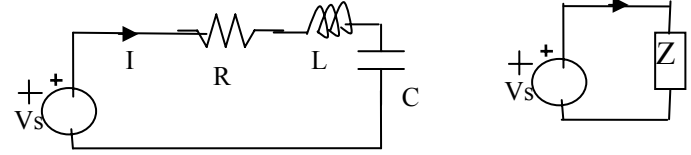
veya

$$S = 0.5 \cdot 100 \cdot 4 e^{j15^\circ} e^{j105^\circ} = 200 e^{j120^\circ} = 200 \cos(120^\circ) + j200 \sin(120^\circ)$$

$$S = -100 + j173.21$$

$$\text{Buradan } P = -100 \text{ W} \quad Q = 173.2 \text{ VAR}$$

381) $v = 20 \cos(5t + 30^\circ)$, $R = 2 \Omega$, $L = 2 \text{ H}$, $C = 0.04 \text{ F}$ ise R, L, C de toplam harcanan a) ortalama gücü, b) reaktif gücü c) Güç faktörünü ve reaktif güç faktörünü hesaplayın



$$V = 20 e^{j30^\circ},$$

$$Z = R + j\omega L + 1/j\omega C = 2 + j5 + 1/(j5 \cdot 0.04)$$

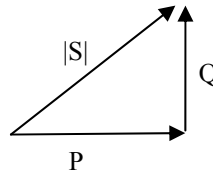
$$= 2 + 10j - 5j = 2 + 5j$$

$$I = V/Z = 20 e^{j30^\circ} / (2 + 5j) = 2.9 - 2.3j = 3.7 e^{-j38^\circ},$$

$$S = \frac{1}{2} \mathbf{V} \mathbf{I}^* = 0.5 \cdot 20 e^{j30^\circ} \cdot 3.7 e^{j38^\circ} = 37 e^{j68^\circ} = 13.7 + j34.35 \text{ VA}$$

$$P = 13.7$$

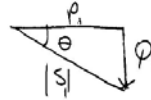
$$Q = 34.35$$



$$\theta = \arctan Q/P$$

$$\text{Güç faktörü} = \cos \theta = P/S = P/\sqrt{P^2 + Q^2} = 0.37$$

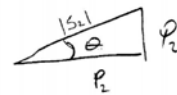
leading power factor 0.8



$$\cos \theta = 0.8$$

θ is minus

lagging power factor 0.6



$$\cos \theta = 0.6 \Rightarrow \theta = 53.1^\circ \Rightarrow$$

$$\sin \theta = 0.8$$