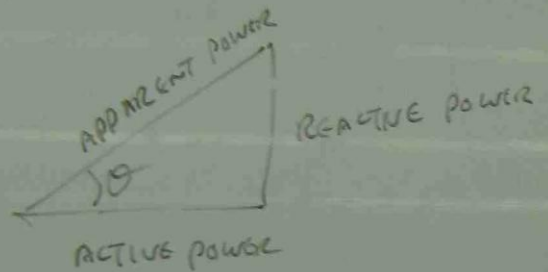
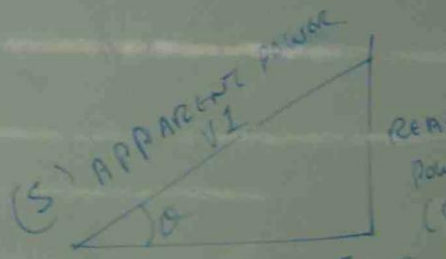
POWER FACTOR & POWER WAVE FREQUENCY

POWER FACTOR



$$PF = \cos\theta$$

COMPLEX POWER COMPONENTS



REAL POWER = $VI\cos\theta$ (P)

$S = VI$ →

$P = VI\cos\theta$ →

$\theta = VI\sin\theta$ →

POWER WAVE FREQUENCY

$$p(t) = \frac{V_m I_m}{2}(1 - \cos 2\omega t)$$

$$= \frac{V_m I_m}{2} - \frac{V_m I_m \cos 2\omega t}{2}$$ — POWER WAVE

EX

A LOAD WHOSE IMPEDANCE $100 \angle 36.9^\circ\ \Omega$ IS SUPPLIED BY A SOURCE WHOSE VOLTAGE IS $300 \angle 0^\circ$ V.

FIND (a) THE APPARENT POWER SUPPLIED TO LOAD

(b) THE REAL POWER SUPPLIED TO LOAD

(c) THE REACTIVE POWER SUPPLIED TO LOAD.

$V = 300 \angle 0\ V$

$Z = 100 \angle 36.9\ \Omega$

$I = ?$

$$I = \frac{V}{Z} = \frac{300 \angle 0}{100 \angle 36.9}$$

$$= 3 \angle 0 - 36.9$$

$$= 3 \angle -36.9\ A$$

METHOD (1)

(a) APPARENT POWER $= VI = 300 \times 3 = 900\ VA$

(b) REAL POWER $= VI\cos\theta = 300 \times 3 \times \cos(-36.9)$

$= 300 \times 3 \times 0.8$

$= 719.7\ W$

(c) REACTIVE POWER $= VI\sin\theta = 300 \times 3 \times \sin(-36.9)$

$= -540\ VAR$

↑ LAGGING.

METHOD (2)

APPARENT POWER $= I^2 Z = 3^2 \times 100 = 900\ VA$

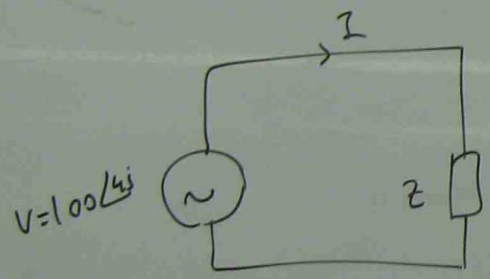
REACTIVE POWER $= I^2 X = 3^2 \times Z\sin\theta = 3^2 \times 1$

$= 5$

ACTIVE POWER $= I^2 R = I^2 Z\cos\theta = 3^2 \times 100$

$= 71$

Pb. FIND THE APPARENT POWER, TRUE POWER AND REACTIVE POWER WHERE A VOLTAGE OF $V = 100 \angle 45$ V IS SUPPLYING A LOAD WHOSE IMPEDANCE IS $Z = 10 + j20\ \Omega$



$$Z = \sqrt{10^2 + 20^2} \quad \angle \tan^{-1}\frac{20}{10}$$

$$Z = 22.36 \angle 63.43$$

$$I = \frac{V}{Z} = \frac{100\angle 45}{22.36\angle 63.4} = 4.47 \angle 45 - 63.43$$

$$= 4.47 \angle -18.43$$

PF ANGLE

APPARENT POWER $= VI = 100 \times 4.47 = 447$ VA

REAL POWER $= VI\cos\theta = 100 \times 4.47 \cos(-18.43)$

$= 447 \times 0.948 = 424$ WATT

REACTIVE POWER $= VI\sin\theta = 100 \times 4.47 \sin(-18.43)$

$= 447 \times (-0.316)$

$= -141.3$ VAR

b) A NETWORK HAS AN EQUIVALENT IMPEDANCE $Z = 3 + j4$ AND AN APPLIED VOLTAGE $V(t) = 42.5 \sin(1000t + 30^\circ)$

FIND

(a) THE APPARENT POWER (S)

(b) THE REAL POWER (P)

(c) THE REACTIVE POWER (Q

(d) THE POWER FACTOR

(c)

42.5 (sin 1000t +30)

Time domain expression

$42.5 \sin(1000t + 30) = \frac{42.5}{\sqrt{2}} \angle 30^\circ = 30 \angle 30^\circ$ V

↑ rms

↑ Frequency domain expression

$$I = \frac{V}{Z} = \frac{30 \angle 30}{\sqrt{3^2+4^2} \angle \tan^{-1} 4/3}$$

$$= \frac{30 \angle 30}{5 \angle 53.2^\circ}$$

$$= 6 \angle 30 - 53.2$$

$$I = 6 \angle -23.2^\circ \text{ A}$$