Basic Electrical and Electronics Engineering BEEE102L

3 phase systems numerical

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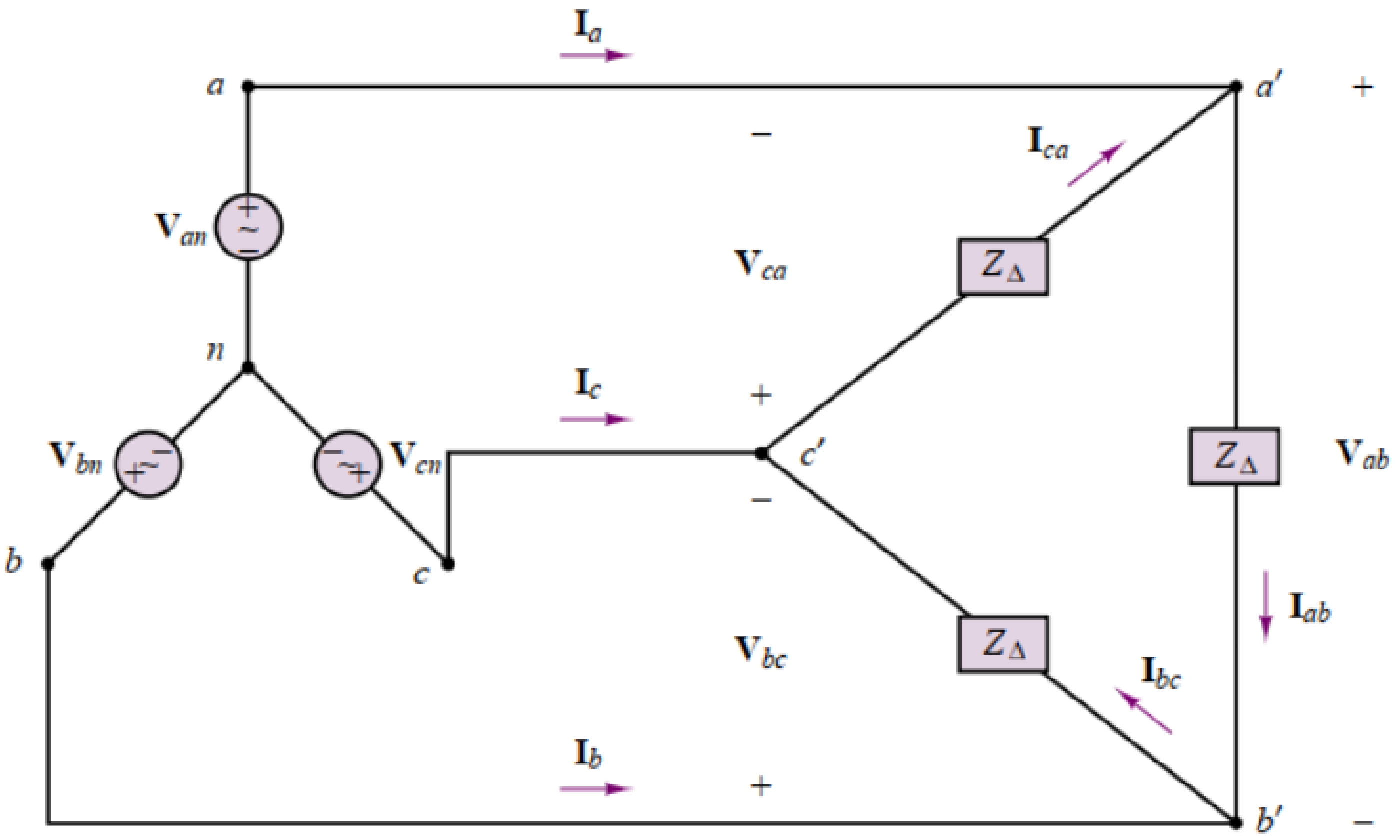
LECTURE 10

Question: 3 Coils having resistance 10 ohms and 42mH are connected in (i) Y and (ii) Delta to a 415 V, 50 Hz 3- phase Supply. Calculate

a) **Line and Phase voltages**
b) **Line and phase currents**
c) **Power consumed by load**
   in both the cases.

Question:: For the three phase system given where Van=Vbn=Vcn=230 V, 50 Hz , with phase impedance is 30+40j. Find the following values: Phase voltages for load, Phase current in load , Supply current by each phase, Power factor, Total power consumed by load .



$V_p = V_{an} = V_{bn} = V_{cn} = 230V, 50Hz$

$V_L = \sqrt{3} V_p = \sqrt{3} \times 230V = 398.37 V$

(i) Phase voltage for load

$V_{p\,(load)} = 398.37V.$

(ii) $I_p = \frac{V_p}{Z_p} = \frac{230}{\sqrt{30^2+40^2}} = 4.6 \text{ Amp.}$

(iii) Supply current = line current of load

$I_L = 4.6 \times \sqrt{3} = 7.967 \text{ Amp.}$

(iv) $\cos\phi = \frac{R}{Z} = \frac{30}{\sqrt{30^2+40^2}} = 0.6$

(v) Power consumed by load,

$P = \sqrt{3} V_L I_L \cos\phi$

$P = \sqrt{3} \times 398.37 \times 7.967 \times 0.6$

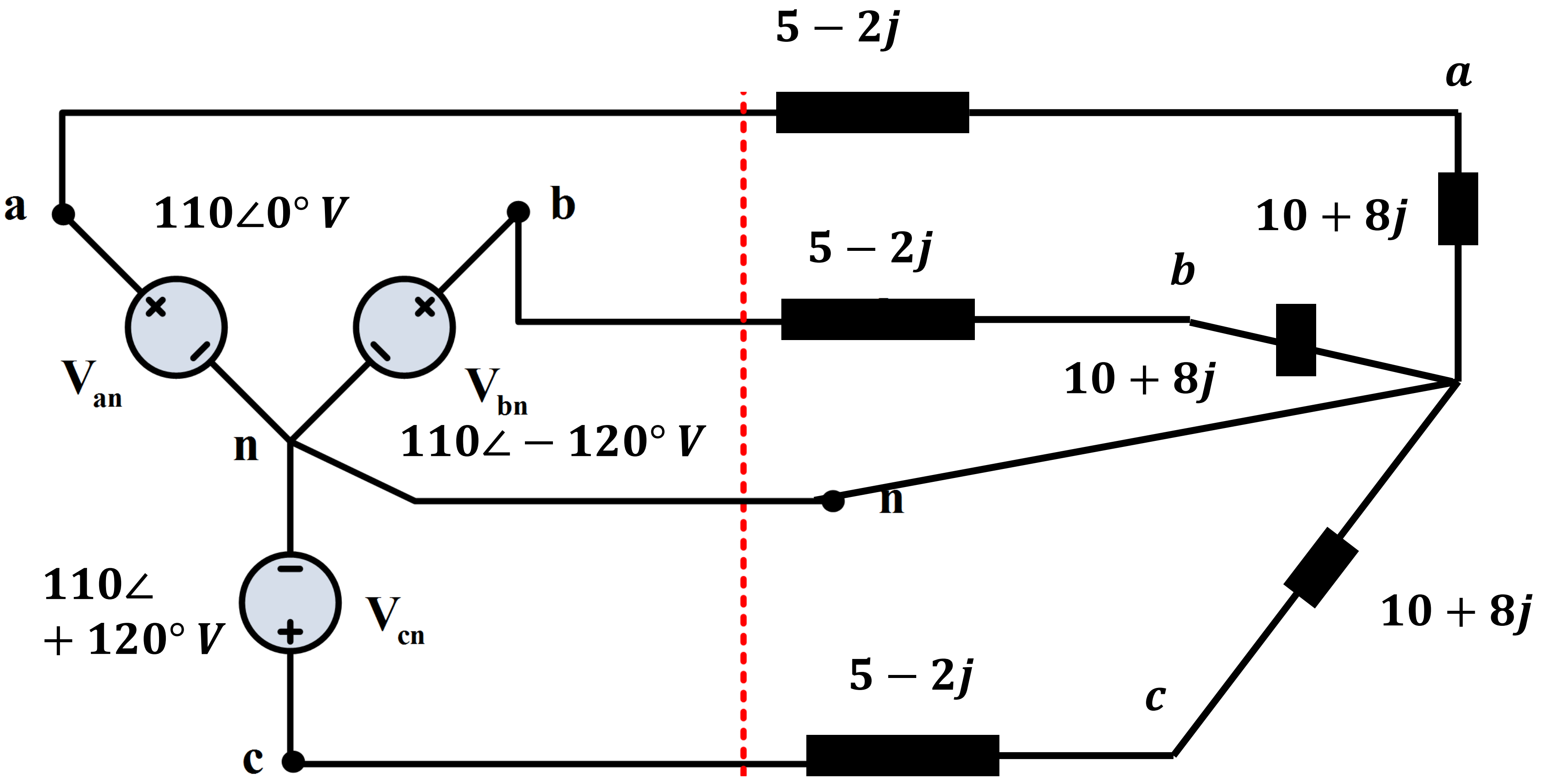
$P = 3.298 \text{ kW.}$

Calculate the current in three wire Y-Y System.

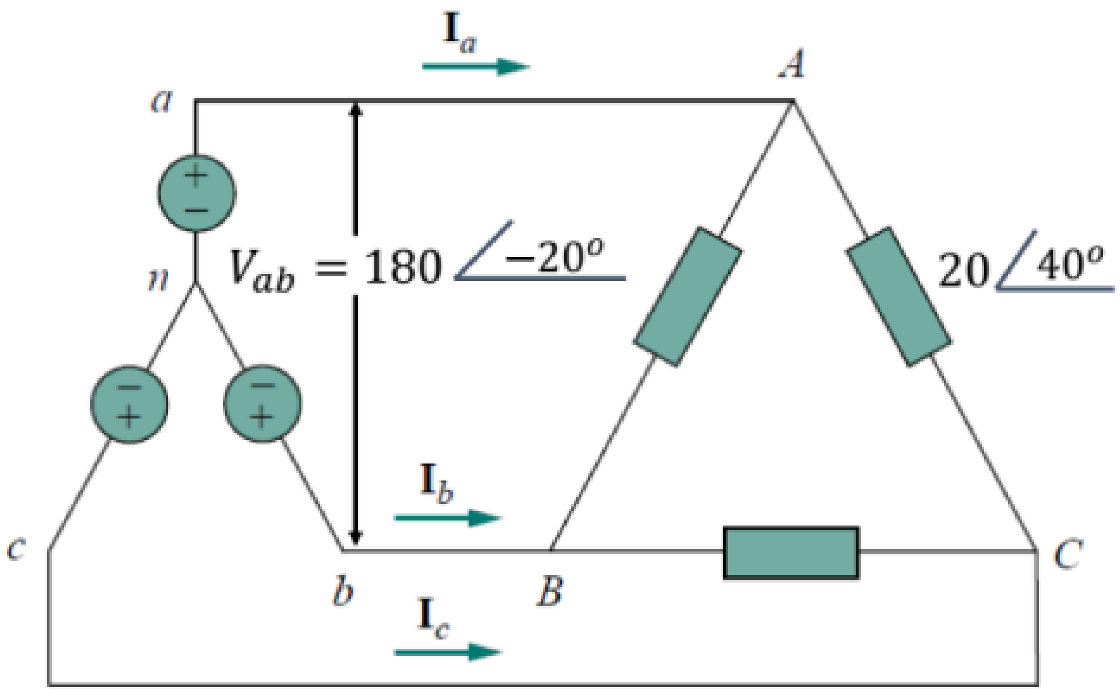
(i) Apparent power absorbed by source.

(ii) Apparent Power absorbed by load

(iii) Apparent Power absorbed by line



One line voltage of a balanced Y-connected source is $180\angle -20^o$. If the source is connected to a balanced Δ-connected load of $20\angle 40^o$. Calculate the (i) phase voltages, (ii) phase currents, (ii) line currents and (iii) complex power at the source and load.



At Source (Y)

Given

$$V_L = 180\angle -20^o \text{ V}$$

Relationship between phase and line, voltage and current in Y connection

$$\boxed{\begin{aligned} V_L &= \sqrt{3}V_P\angle 30^o \\ I_L &= I_P \end{aligned}}$$

(i) phase voltage

$$V_P = \frac{V_L}{\sqrt{3}\lfloor 30^o}$$

$$V_P = \frac{180\lfloor -20^o}{\sqrt{3}\lfloor 30^o}$$

$$V_P = 103.92\angle -30^o \text{ V}$$

At Load (Δ)

Given

$$Z_L = 20\angle 40^o \ \Omega$$

Relationship between phase and line, voltage and current in Δ connection

$$\boxed{\begin{aligned} I_L &= \sqrt{3}V_P\angle -30^o \\ V_L &= V_P \end{aligned}}$$

(i) line voltage

Line voltage of load is equal to line voltage of the source

$$V_{AB} = V_{ab} \quad V_L = 180\angle -20^o \text{ V}$$

(ii) phase voltage

$$V_P = V_L = 180\angle -20^o \text{ V}$$

At Source (Y)

(iii) line current

Line current of source is equal to line current of the load

$$I_L = 15.58\angle -90^o \text{ A}$$

(ii) Phase current

$$I_P = I_L = 15.58\angle -90^o \text{ A}$$

(iii) Complex power

$$S = -(P + jQ)$$

$$S = -(3V_P I_P \cos(\theta_V - \theta_i) + j3V_P I_P \sin(\theta_V - \theta_i))$$

$$= -\big(3(103.92)(15.58)\cos(-50^0 + 90^o) +$$
$$j3(103.92)(15.58)\sin(-50^o + 90^o)\big)$$

$$S = -(3720.847 + j3122.16) \text{ VA}$$

At Load (Δ)

(iii) phase current

$$I_P = \frac{V_P}{Z} = \frac{180\angle -20^0}{20\angle 40^o}$$

$$= 9\angle -60^o \text{ A}$$

(iii) line current

$$I_L = \sqrt{3} I_P \angle -30^o$$

$$I_L = \sqrt{3}(9)\angle -60^o \angle -30^o$$

$$I_L = 15.58\angle -90^o \text{ A}$$

(iii) Complex power

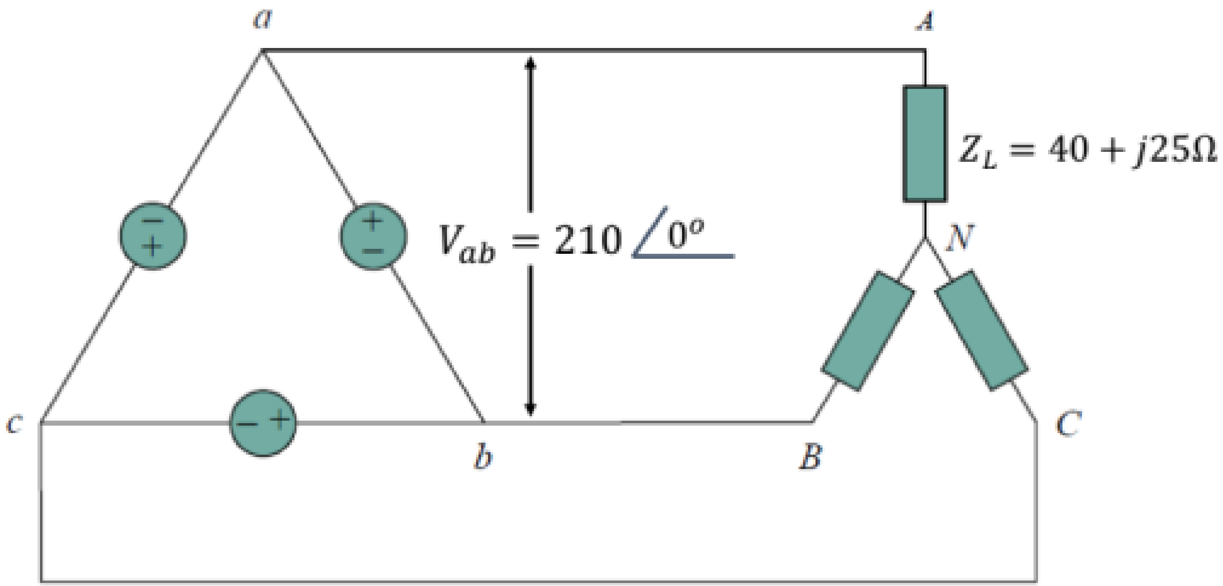
$$S = P + jQ$$

$$S = 3V_P I_P \cos(\theta_V - \theta_i) + j3V_P I_P \sin(\theta_V - \theta_i)$$

$$= 3(180)(9)\cos(-20^0 + 60^o) +$$
$$j3(180)(9)\sin(-20^o + 60^o)$$

$$S = 3722.98 + j3123.95 \text{ VA}$$

A balanced Y-connected load with a phase resistance of 40Ω and a reactance of 25Ω is supplied by a balanced Δ-connected source with a line voltage of 210 V. Calculate the (i) phase voltages, (ii) phase currents, (ii) line currents and (iii) complex power at the source and load.



At Source (Δ)

Given

$$V_L = 210\angle 0^o \text{ V}$$

Relationship between phase and line, voltage and current in Δ connection

$$\boxed{\begin{aligned} I_L &= \sqrt{3}V_P\angle -30^o \\ V_L &= V_P \end{aligned}}$$

(i) phase voltage

$$V_P = V_L = 210\angle 0^o \text{ V}$$

At Load (Y)

Given

$$Z = 40 + j25\,\Omega \quad Z_L = 47.17\angle 32.005^o$$

Relationship between phase and line, voltage and current in Y connection

$$\boxed{\begin{aligned} V_L &= \sqrt{3}V_P\angle 30^o \\ I_L &= I_P \end{aligned}}$$

(i) line voltage

Line voltage of load is equal to line voltage of the source

$$V_{AB} = V_{ab} \quad V_L = 210\angle 0^o \text{ V}$$

(ii) phase voltage

$$V_P = \frac{V_L}{\sqrt{3}\lfloor 30^0}$$

$$V_P = 121.24\angle -30^o \text{ V}$$

At Source (Δ)

(iii) line current

Line current of source is equal to line current of the load

$$I_L = 2.57\angle{-62.005^o}\ \text{A}$$

(ii) Phase current

$$I_P = I_L/(\sqrt{3}\angle{-30^o})$$

$$I_P = (2.57)/\sqrt{3})\angle{-62.005^o}/\angle{30^o}$$

$$I_P = 1.483\angle{-32.005^o}\ \text{A}$$

(iii) Complex power

$$S = -(P + jQ\ )$$

$$S = -(3V_P I_P \cos(\theta_V - \theta_i) + j3V_P I_P \sin(\theta_V - \theta_i))$$

$$= -\big(3(210)(1.483)\cos(0^0 + 32.005^o) +$$

$$j3(210)(1.483)\sin(0^0 + 32.005^o)\big)$$

$$S = -(792.28 + j495.17)\ \text{VA}$$

At Load (Y)

(iii) phase current

$$I_P = \frac{V_P}{Z_L} = \frac{121.24\lfloor{-30^0}}{47.17\lfloor 32.005^o}$$

$$= 2.57\lfloor{-62.005^o}\ \text{A}$$

(iii) line current

$$I_P = I_L = 2.57\angle{-62.005^o}\ \text{A}$$

(iii) Complex power

$$S = P + jQ$$

$$S = 3V_P I_P \cos(\theta_V - \theta_i) + j3V_P I_P \sin(\theta_V - \theta_i)$$

$$= 3(121.24)(2.57)\cos(-30^0 + 62.005^o) +$$

$$j3(121.24)(2.57)\sin(-30^o + 62.005^o)$$

$$S = 792.68 + j495.42\ \text{VA}$$

Question: Find the real power absorbed by the load for the three-phase circuit shown in Fig.1

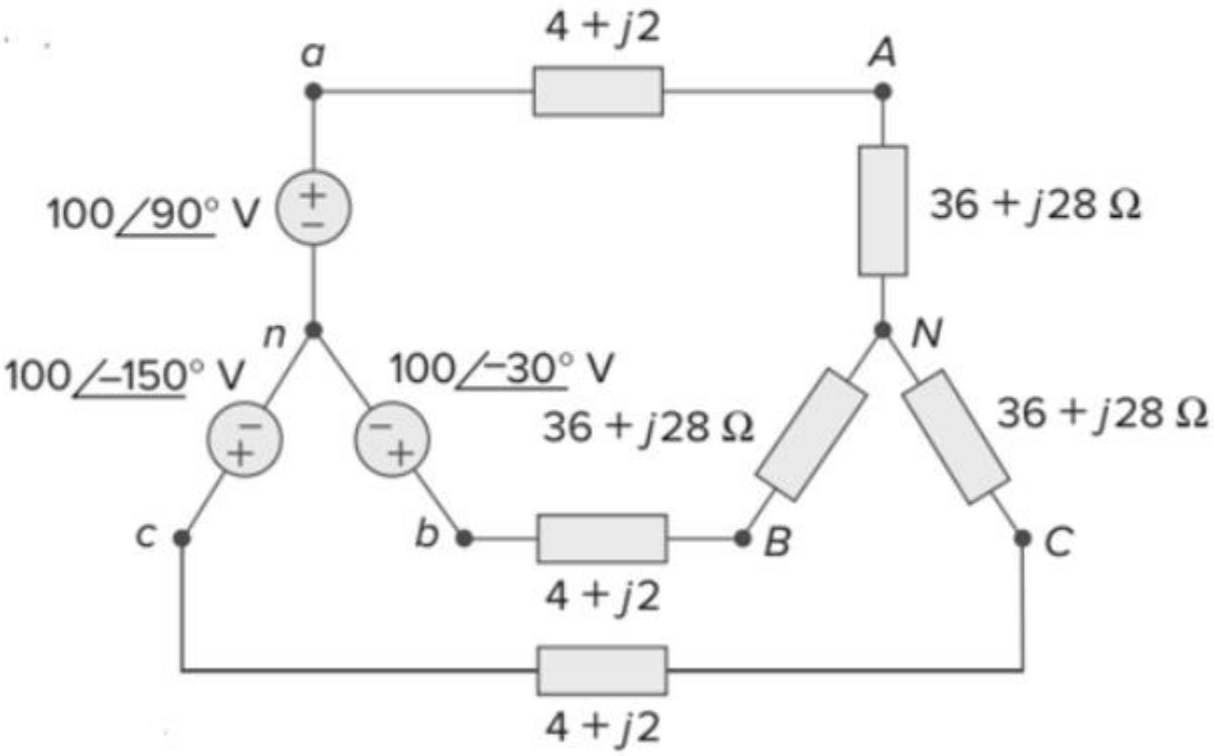


Fig.1

Question: Find the real power absorbed by the load for the three-phase circuit shown in Fig.1

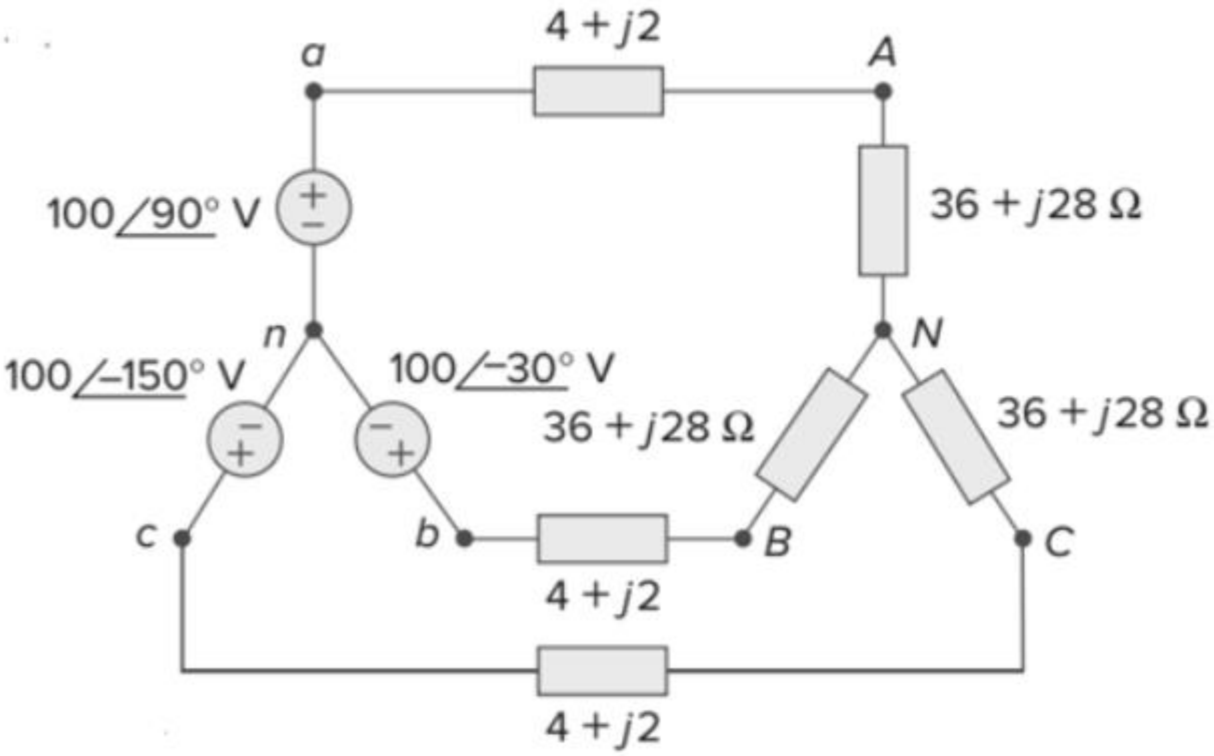


Fig.1

Answer: 432.02W