9

7.48

✓ Answer

When converting the wye to a star, everything becomes shorted, and thus there is no equivalent, it just becomes a short.

7.78

Use the Mesh-Current technique

✓ Answer

In the order of the left voltage source, right voltage source, and current source, V_a would be:

$4.23529411764706 - 4.94117647058824i$,
$-11.2941176470588 + 3.17647058823529i$,
$10.5882352941176 + 37.6470588235294i$

Therefore, $V_a = 3.52941176470588 + 35.8823529411765i$
$= 36.06\angle 84.38^\circ\ V$

```
from cmath import polar
from sympy import symbols, solve
from sympy.matrices import Matrix

l1 = complex(0, 6)
r1 = 9
c1 = complex(0, -10)
c2 = complex(0, -4)

v1r = 20
i1r = 10
v2r = 30

i1, i2, i3, v1, v2, v3 = symbols("i1, i2, i3, v1, v2, v3")


R = [
    Matrix([[l1 + r1, -r1], [-r1, c1 + c2 + r1]]),
    Matrix([[l1 + r1, -r1], [-r1, c1 + c2 + r1]]),
```

```
    Matrix([[l1 + r1, -r1, 0], [-r1, c1 + c2 + r1, -c1], [0, -c1, c1]]),
]

I = [
    Matrix([[i1, i2]]).T,
    Matrix([[i1, i2]]).T,
    Matrix([[i1, i2, -i1r]]).T,
]

V = [
    Matrix([[v1r, 0]]).T,
    Matrix([[0, -v2r]]).T,
    Matrix([[0, 0, v3]]).T
]

S = [solve([r*i - v], i1, i2, v3) for r, i, v in zip(R, I, V)]
va = [(s[i2] * c2).evalf() for s in S]
Va = sum(va)
display(va)
display(Va)
polar(Va)
```

7.79

Answer

Solving:

$(v_1 - 10)/5 + (v_1)/(-2i) + (v_1)/5 = 0$

$(-v_1)/5 + (-v_o)/(-4i) = 0$

Gives us:

$v_o = 1.95121951219512 + 1.5609756097561i$

$2.50\angle 38.66^{\circ}\ V$

```
from cmath import polar
from sympy import symbols, solve
from sympy.matrices import Matrix

v1, vo = symbols("v1, vo")

s = solve([
        (v1-10)/5 + (v1)/(-2j) + (v1)/5,
        (-v1)/5 + (-vo)/(-4j)
    ], v1, vo
)
display(s[vo])
polar(s[vo])
```

8.31

✓ **Answer**

Solving:

$$\begin{bmatrix} 5.0 - 1.0i & 1.0i & 0 \\ 1.0i & 2.0 + 1.0i & -2 \\ 0 & -2 & 8.0 + 4.0i \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 10.6066017177982 + 10.6066017177982i \\ -2i_2 \\ 2i_2 \end{bmatrix}$$

We get:

$i_3 = 0.0420658425068484 - 0.354554958272008i$

$P = 0.46\angle 33.69^\circ\ W$

```
from cmath import polar, rect
from sympy import symbols, solve
from sympy.matrices import Matrix

r1 = 5
r2 = 2
c1 = -1j
l1 = 2j
zl = 6+4j

v1r = rect(15, 45 / 180 * pi)

i1, i2, i3 = symbols("i1, i2, i3")

R = Matrix([[r1 + c1, -c1, 0], [-c1, c1 + l1 + r2, -r2], [0, -r2, r2 +
zl]])
I = Matrix([[i1, i2, i3]]).T
V = Matrix([[v1r, -2 * i2, 2 * i2]]).T

S = solve([R*I - V], i1, i2, i3)

p = polar(S[i3])[0] ** 2 * zl / 2
display(p)
polar(p)
```

8.33

✓ **Answer**

$v_i = 8$

$r_1 = 5000$

$r_l = 2000$

$c_1 = -5000j$

$c_2 = -1064j$
$(v_o - v_i)/r_1 + (v_o - v_i)/c_1 + (v_o)/c_2 = 0$

Gives us $P_{av} = 1mW$

```
from cmath import polar
from sympy import symbols, solve
from sympy.matrices import Matrix

vi = 8
r1 = 5000
rl = 2000
c1 = -5000j
c2 = -1064j
vo = symbols("vo")

s = solve([
        (vo-vi)/r1 + (vo-vi)/c1 + (vo)/c2
    ], vo
)
i1 = abs(s[vo]/rl)
i1 ** 2 * rl / 2
```