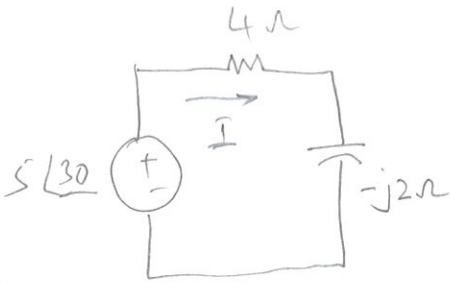
Ch10 HW Problems, Solutions

Problem 1: 25

In the circuit, find P & Q from the source.

Find Average Power in Resistor and Reactive power in Capacitor



$$\bar{I} = \frac{5\angle 30^\circ}{4 - j2} = 1.118\angle 56.57^\circ \text{ Amps}$$

0.894

$$P_s = \frac{1}{2} V_m I_m \cos(30^\circ - 56.57^\circ) = \frac{1}{2} * 5 * 1.118 \cos -26.57$$

$$= 1.6 \text{ Watts}$$

1.6

$$Q_s = \frac{1}{2} V_m I_m \sin(-26.57^\circ) = \frac{1}{2} \times 5 \times 1.118 \times -0.447$$

$$= -1.25 \text{ VAR}$$

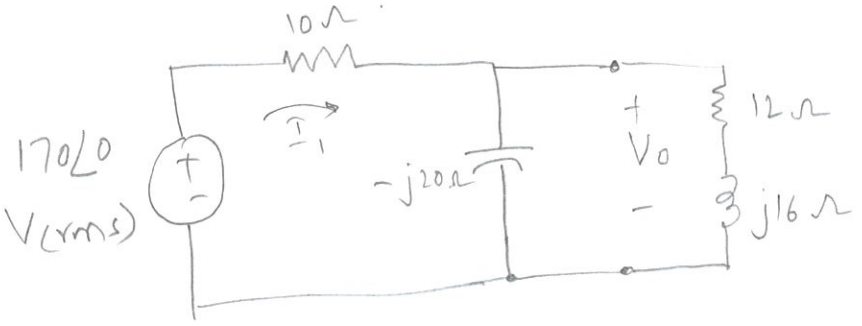
-0.8

$$P_{4\Omega} = \frac{1}{2} I_m^2 R = \frac{1}{2} * 1.118^2 * 4 = 1.6 \text{ Watts}$$

$$Q_{j2\Omega} = \frac{1}{2} I_m^2 X_c = \frac{1}{2} * 1.118^2 * (-2) = -1.25 \text{ VARS}$$

-0.8Vars

Problem 2: 25



a). find P and Q from source

We first need to find $\bar{I}_1$.

KVL1 $-170\angle 0^\circ + 10\bar{I}_1 + (-j20)(\bar{I}_1 - \bar{I}_2) = 0$

or $(10 - j20)\bar{I}_1 + j20\bar{I}_2 = 170\angle 0 \rightarrow (1)$

KVL2 $-(-j20)(\bar{I}_1 - \bar{I}_2) + 12\bar{I}_2 + j16\bar{I}_2 = 0$

or $j20\bar{I}_1 + 12\bar{I}_2 - j4\bar{I}_2 = 0$

or $j20\bar{I}_1 + (12 - j4)\bar{I}_2 = 0 \rightarrow (2)$

Solving (1) & (2) $\bar{I}_1 = 4 + j$ Amps $= \sqrt{17}\angle 14.0^\circ$ (rms) A

$\bar{I}_2 = 3.5 - j5.5$ Amps $= 6.52\angle -57^\circ$ A (rms)

Then $\bar{S} = -V_g I_1^* = -170(4 - j)$ (Note -ve sign in $\bar{S}$ formula!)

$\bar{S} = -680 + j170$ VA

b). Source is delivering 680 Watts ✓

c) " " absorbing 170 VARs ✓

d). $P_{10} = I_{rms}^2 R = (\sqrt{17})^2 * 10 = 170$ W

$P_{12} = (6.52)^2 12 = 510$ W

$Q_{20} = |(\bar{I}_1 - \bar{I}_2)|^2 x_{-20} = -6.52^2 \times 20 = -850$ VARs (delivered)

$Q_{j16} = 6.52^2 \times 16 = +680$ VARs (absorbed)

e). $\Sigma P_{abs} = 170 + 510 = 680 = \Sigma P_{del}$

f) $\Sigma Q_{abs} = 170 + 680 = 850 = \Sigma Q_{Del}$

Problem 3:

pf needs to be raised from 0.8 lag to 0.95 lag. Find C.

Given $P = 4000$, at pf of 0.8

So $S = \frac{P}{\cos\theta}$ So $\cos\theta = 0.8$, $\theta = 36.87°$

$\sin\theta = 0.6$

$= 5000$ VA

$Q = S\sin\theta$

$= 3000$ VAR

If pf is raised to 0.95, $\cos\theta_2 = 0.95 \Rightarrow \theta_2 = 18.19°$

$\sin\theta_2 = 0.312$

New $S_2 = \frac{P}{\cos\theta_2} = \frac{4000}{0.95} = 4210.5$ VA

New, $Q_2 = S_2\sin\theta_2 = 1314.4$ VAR.

So VAR drops from 3000 VAR to 1314.4 VAR,

or by 1685.6 VAR

This VAR is due to Capacitor, C

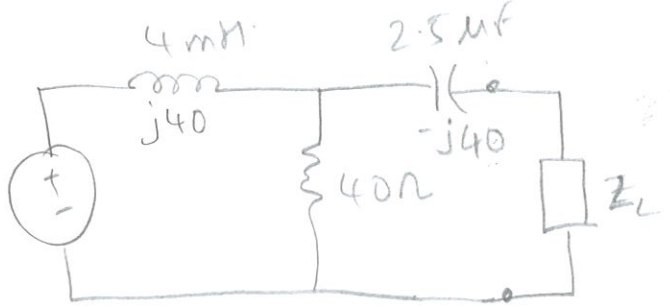
$Q_C = 1685.6$ VAR. $Q_C = \frac{|V_{rms}|^2}{X_C}$

So $X_C = \frac{120^2}{-1685.6} = -8.54\ \Omega$.

i.e. $\frac{1}{\omega C} = -8.54\ \Omega$ Using $\omega = 2\pi f = 120\pi$

$C = \frac{-1}{120\pi \times -8.54} = 0.000310$ F $= 310\ \mu$F

Pr 4
25



$\omega = 10{,}000$ rad/s

$v_g = 120\cos 10{,}000t$ V

a) Find Z_L for max average power.

We need to find V_{Th} & Z_{Th}

$$V_{Th} = V_{OC} = \frac{40}{40+j40}(120)$$

$$= 60 - j60 \text{ volts}$$

$X_L = j\omega L$
$= 10{,}000 \times 4 \times 10^{-3}$
$= j40\ \Omega$

$X_C = \frac{-j}{\omega C}$
$= -j40\ \Omega$

Z_{Th}, by deactivating the V_g

$$Z_{Th} = -j40 + 40 \| j40$$

$$= 20 - j20\ \Omega$$

So $Z_L = Z_{Th}^*$, for max average power

$$Z_L = 20 + j20\ \Omega$$

b) $$P_{max} = \frac{|V_{Th}|^2}{8R_{Th}} = \frac{(60\sqrt{2})^2}{8 * 20} = 45 \text{ Watts}$$