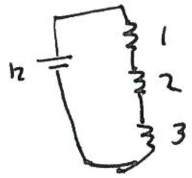
1)



$I = \frac{12}{6} = 2\,mA$ ← every resistor $\qquad \frac{V}{k\Omega} = mA$

$V_1 = IR_1 = 2\,V$

$V_2 = IR_2 = 4\,V$

$V_3 = IR_3 = 6\,V$

$\overline{\qquad 12\,V}$

$P = \frac{V^2}{R} = \frac{12^2}{6\,k\Omega} = 24\,mW$

2)

$V = 12\ V$ ← every resist

$I_1 = \frac{V}{R_1} = 12\,mA$

$I_2 = \frac{V}{R_2} = 6\,mA$

$I_3 = \frac{V}{R_3} = 4\,mA$

$\overline{\qquad 22\,mA}$

$P = V \cdot I = 12 \cdot 22\,mA$

$= 264\,mW$

5) $5 \| 3 \| 2 = \frac{1}{\frac{1}{5}+\frac{1}{3}+\frac{1}{2}} = .9677$

current thru 7 : $\frac{15}{7+} = 1.883\,mA$

Volts across 7: $7 \cdot \quad = 13.18\,V \Rightarrow 15 - 13.18$ across 5, 3, 2

$= \underline{1.822\,V}$

current thru 5: $\frac{1.822}{5} = .364\,mA$

$3 = \frac{1.822}{3} = .6073$

$2 = \frac{1.822}{2} = .9109$

$\overline{\qquad 1.883\,mA}$

current thru $11 = \frac{15V}{11} = 1.364\,mA$

6) $P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P} = \frac{120^2}{100} = 144\,\Omega$

11) $v = A\sin(\omega t + \phi) + B$

a) DC off $= B = 1V$

b) amp $= A = 5V$

c) peak $= A + B = 6V$

d) p-p $= 2A = 10V$

e) rms $= \frac{A}{\sqrt{2}} = 3.54V$

f) $v = A\sin(\phi) + B = 5\overbrace{\sin(.45^r)}^{.435} + 1$

$= 3.175V$

g) $f = \frac{\omega}{2\pi} = \frac{1000}{2\pi} = 159\,Hz$

h) $T = \frac{1}{f} = 6.28\,ms$

13) $I = \frac{V}{X_L} = \frac{V}{\omega L}$ ($V \leftarrow 120V$, $\omega \leftarrow 2\pi \cdot 60$, $I \leftarrow 20A$) $\Rightarrow L = \frac{120V}{20A \cdot 2\pi \cdot 60} = 15.9\,mH$

$= \frac{V}{X_C} = \omega C V \Rightarrow C = \frac{I}{\omega V} = \frac{20A}{2\pi \cdot 60 \cdot 120} = 442\,\mu F$

Zero power consumed – V & I 90° out-of-phase $\langle VI \rangle = 0$

i.e. phase angle = 90° & $\cos(90°) = 0$

14) $Z_T = R + Z_C + Z_L = 1000\Omega + i\left(\underbrace{\omega \cdot .2}_{1.26K} - \underbrace{\frac{1}{\omega C}}_{1.59K}\right)$ ($\omega = \underbrace{2\pi \cdot 1000}_{6.28 \times 10^3}$, $C \leftarrow 10^{-7}$)

$= (1, -.335)\,K$

$I = \frac{10}{Z} = (8.99, 3.01)^{mA} = 9.48 \angle \underbrace{.32^r}$ mA

phase diff twix V & I = $\underline{18.5°}$

$V_R = RI = (8.99, 3.01)\,V$

$= 9.48\,V_{rms}$

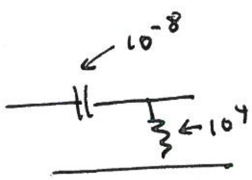
$V_L = j\omega L \cdot (8.99, 3.01) = (-3.78, 11.3) = 11.9 \angle 108°$ ✓

ωL: $2\pi \cdot 1000 \cdot .2 \Rightarrow 1.257K\Omega$

$V_C = \frac{-j}{\omega C}(8.99, 3.01) = (4.79, -14.3) = 15.1V \angle -71°$ ✓

note: to add all: $(10, 0)$ = source!

17) High pass



$f_{-3db} = \frac{1}{2\pi RC} = 1.59\,KHz$

a) $I = \frac{V}{R - \frac{j}{\omega C}} = \frac{V/R}{1 - \frac{j}{\omega RC}} = \frac{V/R}{1 - j\frac{f_{-3db}}{f}} = \frac{1mA}{1 - j\frac{1.59}{1}}$

$= \frac{1mA}{1.88 \angle -58°} = .532mA \angle +58°$

phase betwe Vin & Vout

b) $V_R = IR = \frac{V}{1 - j\frac{f_{-3db}}{f}} = \frac{10V}{1 - j\frac{1.59}{1}} = \frac{10V}{1.88 \angle -58°} = \underline{5.32V \angle +58°}$ ✓

c) $V_C = I\left(\frac{-j}{\omega C}\right) = \frac{V}{1 - j\frac{f_{-3db}}{f}}\left(-j\frac{f_{-3dB}}{f}\right) = \frac{-j\,10\left(\frac{1.59}{1}\right)}{1 - j\frac{1.59}{1}} = \frac{15.9 \angle -90°}{1.88 \angle -58}$

$= 8.46 \angle -32°$ ✓

18) Low Pass

$$f_{-3dB} = \frac{1}{2\pi \underset{50}{R} \underset{6.8\times10^{-6}}{C}} = 468\ Hz = .468\ kHz$$

$$\frac{1}{2\pi f R C} = \frac{f_{-3dB}}{f}$$

$$I = \frac{V}{R - \frac{j}{\omega C}} = \frac{V/R}{1 - \frac{j}{\omega RC}} = \frac{V/R}{1 - j\frac{f_{-3dB}}{f}} = \frac{.1/50}{1 - j\frac{.468}{1}}$$

$$= \frac{.1/50}{1.104 \angle -25^\circ} = 1.81\ mV \angle +25^\circ$$

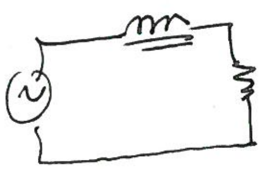
$$V_R = I \cdot 50 = .0906\ V$$

$$V_C = \frac{-j}{\omega C} I = \frac{-j}{\omega RC} \frac{V}{1 - \frac{j}{\omega RC}} = -j \frac{f_{-3dB}}{f} \frac{V}{1 - \frac{j}{\omega RC}}$$

$$= \frac{(.1)(.468)\angle -90^\circ}{1.104 \angle -25^\circ} = .0424 \angle -65^\circ\ V$$

angle between V_{out} & V_{in}

23)



$$P = I^2 R \Rightarrow R = 146\ \Omega$$

P: 20W, I: .37 A

$\hookrightarrow V_R = (1.46)(.37) = \underline{54V}$

$$I = \frac{V}{R + j\omega L} \Rightarrow |I| = \frac{|V|}{\sqrt{R^2 + \omega^2 L^2}} \quad \text{or} \quad R^2 + \omega^2 L^2 = \frac{V^2}{I^2}$$

$$\omega^2 L^2 = \frac{V^2}{I^2} - R^2 \qquad L = \frac{1}{\omega}\sqrt{\frac{V^2}{I^2} - R^2}$$

632

$$= \frac{1}{2\pi \cdot 50}\sqrt{\left(\frac{240}{.37}\right)^2 - 146^2}$$

$$= \boxed{2.01\ H}$$

25) Require $(R+j\omega L) \parallel \frac{-j}{\omega C}$ to be real

$$Z_{net} = \frac{(R+j\omega L)\left(\frac{-j}{\omega C}\right)}{R+j\left(\omega L - \frac{1}{\omega C}\right)} = \frac{+\frac{L}{C} - j\frac{R}{\omega C}}{R + j\left(\omega L - \frac{1}{\omega C}\right)}$$

$$= \frac{R^2\left(\frac{L}{R^2C} - j\frac{1}{\omega RC}\right)}{R\left(1+j\left(\frac{\omega L}{R} - \frac{1}{\omega RC}\right)\right)} = \frac{\frac{L}{C}\left(1 - j\frac{R}{\omega L}\right)}{R\left(1+j\left(\frac{\omega L}{R}-\frac{1}{\omega RC}\right)\right)}$$

if this is going to be real top & bottom must have same phase $\Rightarrow$ $\frac{R}{\omega L} = \frac{1}{\omega RC} - \frac{\omega L}{R}$

$$\frac{R}{\omega L}+\frac{\omega L}{R} = \frac{1}{\omega RC}$$

$$\omega RC = \frac{1}{\frac{R}{\omega L}+\frac{\omega L}{R}}$$

$\omega = 2\pi \cdot 5$

$L = 2$

$R = 146\ \Omega$

$$C = \frac{\frac{1}{\omega R}}{\frac{R}{\omega L} + \frac{\omega L}{R}}$$

$\frac{1}{2\pi \cdot 50 \cdot 146}$

$\frac{2\pi \cdot 50 \cdot 2}{146} = 4.3$

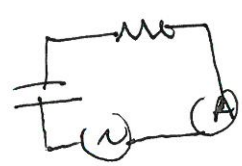
$$= \frac{21.8\ \mu F}{4.536} = 4.81\ \mu F$$

26) $Z = R + j\left(\omega L - \frac{1}{\omega C}\right) = 75 + j\left(\underbrace{10^5 \cdot 10^{-2}}_{1000 = 1K} - \frac{1}{10^{-8}\cdot 10^5}\right)$

$= 75\ \Omega$

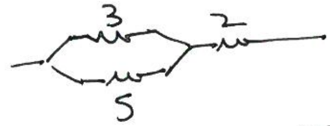
$V_L = X_L \cdot I = 1K\Omega \cdot \frac{5}{75} = 66.7\ V$ (resonance)

(A) shorts out L so circuit is



$$I = \frac{V}{\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}} = \frac{V}{\sqrt{75^2 + 1000^2}} \approx \underline{5\,mA}$$

28) (A) $V_{TH} = \frac{5}{8} 12 = 7.5\,V$ $R_{TH} =$

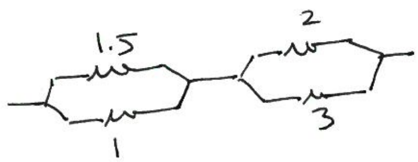


$3 \| 5 + 2 = \underline{3.875\,k\Omega}$

(B) $V_{TH} = \Delta V = \left(\frac{1}{2.5} - \frac{3}{5} \right) 15\,V$

$= \left(\frac{2}{5} - \frac{3}{5} \right) 15V = -\frac{1}{5} 15 = -3\,V$ just depends on which terminal you call "red"

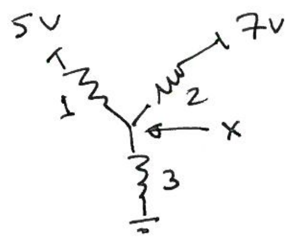
$R_{TH} =$



$1 \| 1.5 + 2 \| 3 = 1.8\,k\Omega$

(C) R_{TH} is easy: $1 \| 2 \| 3 = \underline{.546\,k\Omega}$

V_{TH} is harder — K's Law or I'll use node formula



$$\frac{(5-x)}{1} + \frac{(7-x)}{2} + \frac{(0-x)}{3} = 0$$

$$5 + \frac{7}{2} + 0 = \left(\frac{1}{1} + \frac{1}{2} + \frac{1}{3} \right) x$$

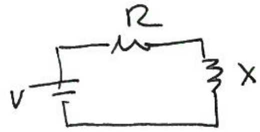
$$\frac{5 + \frac{7}{2}}{\left(\frac{1}{1} + \frac{1}{2} + \frac{1}{3} \right)} = x = \underline{4.64\,V}$$

29) $R_{TH} = 2 \| 4 = 1.33\,k\Omega$

find V_{TH} from current $= \frac{5V}{6\Omega} \Rightarrow V_{TH} = 4 \cdot \frac{5}{6} = 3.333$

charges → Current $= \frac{\Delta V = 2\frac{1}{3}}{R = 4/3} = \frac{7/3}{4/3} = \underline{\frac{7}{4}\,mA}$

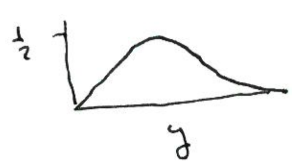
1.11:



: Power $= \underbrace{I^2 R}_{\text{generic}} = \left[\frac{V}{(R+x)} \right]^2 \cdot x = \frac{V^2}{R} \frac{y}{(1+y)^2}$

plot

where $y = \frac{x}{R}$



$$f(y) = \frac{y}{(1+y)^2}$$

$$f'(y) = \frac{1}{(1+y)^2} - \frac{2y}{(1+y)^3} = \frac{1+y-2y}{(1+y)^3} = \frac{1-y}{(1+y)^3}$$

$= 0 \Rightarrow y = 1$