Homework 5

Rules:

1、Work on your own. Discussion is permissible, but extremely similar submissions will be judged as plagiarism.

2、Please show all intermediate steps: a correct solution without an explanation will get zero credit.

3、Please submit on time. No late submission will be accepted.

4、Please prepare your submission in English only. No Chinese submission will be accepted.

1、Simplify the following expressions and give the answer with exponential form.

(a) $\frac{j*(-5+3j)-5}{\frac{8-3j}{6+j}-(1-6j)*(8-9j)}$

(b) $(7-8j)^2\sqrt{(10-j)*(4+7j)}$

(c) $\frac{(3\angle 75°+10\angle 108°)*7j}{(3-9j)*(-1-4j)*8\angle 10°}$

(a) $0.13e^{j161.99}$

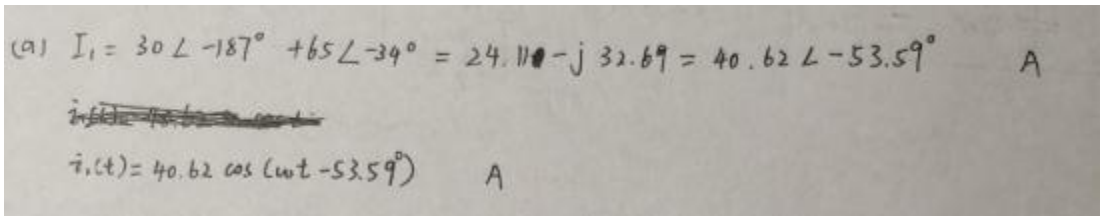
(b) $1.02*10^3*e^{-j70.35}$ or $1.02*10^3*e^{j109.65}$

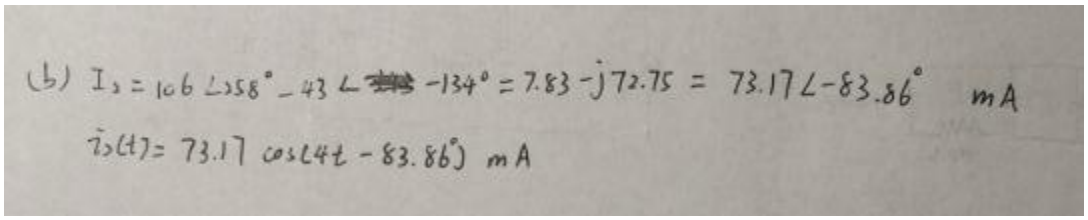
(c) $0.28e^{-j3.84}$

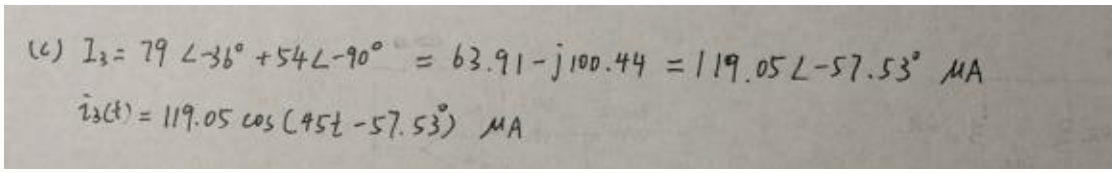
每小问4分，一共12分

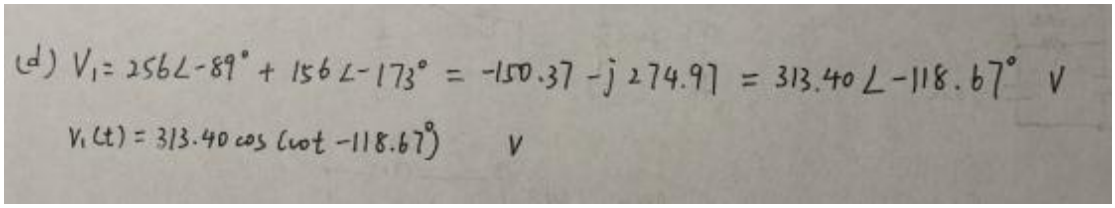
2、Simplify the following expressions by using phasors

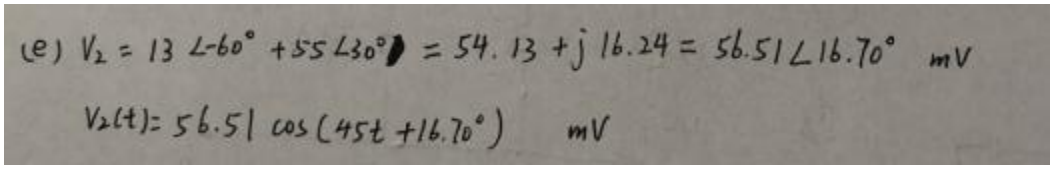
(a) $i_1(t) = 30\sin(\omega t-97^\circ)+65\sin(\omega t+56^\circ)$A
(b) $i_2(t) = 106\sin(4t+348^\circ)-43\cos(4t-134^\circ)$mA
(c) $i_3(t) = 79\cos(45t-36^\circ)+54\sin(45t)$ μ A
(d) $v_1(t) =256\sin(\omega t+1^\circ)+156\cos(\omega t-173^\circ)$V
(e) $v_2(t) = 13\cos(45t-60^\circ)+55\cos(45t+30^\circ)$mV
(f) $v_3(t) = 30\sin(99t)-65\cos(99t)$ μ V

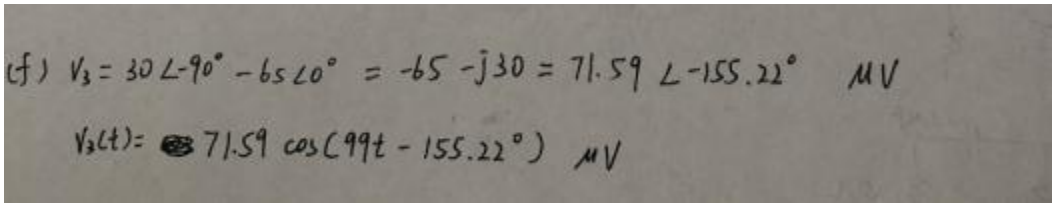












每小问2分，一共12分

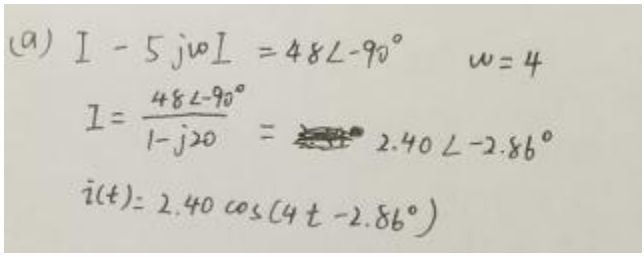
3、Find steady state solution of $v(t)$ or $i(t)$ in the following differential equations using the phasor approach:

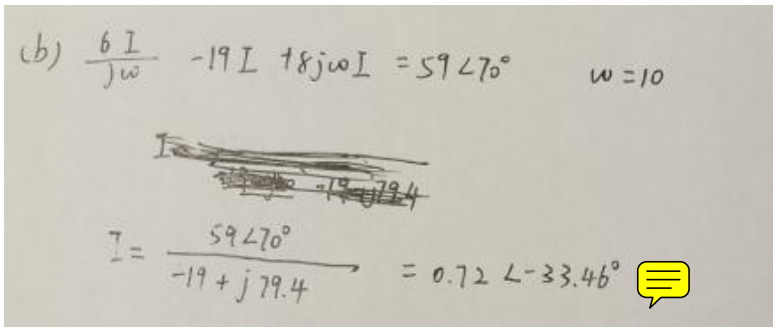
(a)$\mathrm{i(t)} - 5 * \frac{di(t)}{dt} = 48\sin(4t)$

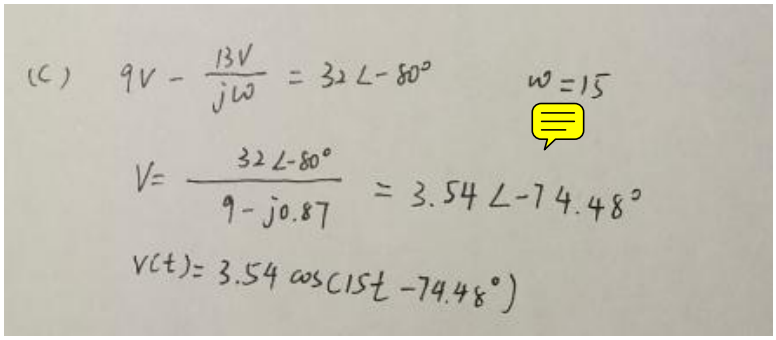
(b)$6\int i(t)dt - 19\mathrm{i(t)} + 8\frac{di(t)}{dt} = 59\cos(10t + 70°)$

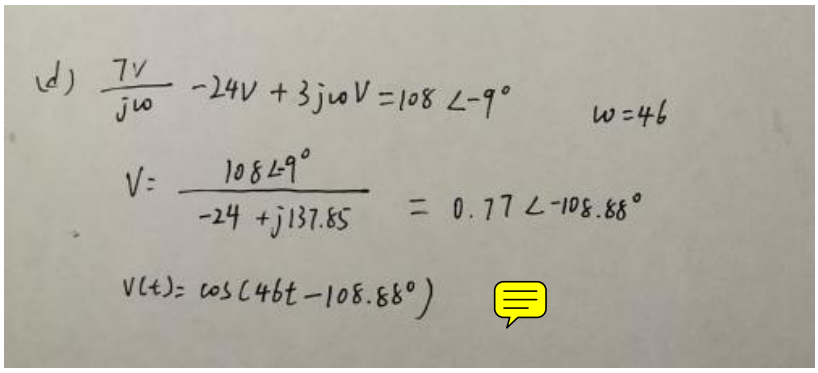
(c)$9\mathrm{v(t)} - 13\int v(t)dt = 32\sin(15t + 10°)$

(d)$7\int \mathrm{v}(t)dt - 24\mathrm{v(t)} + 3\frac{dv(t)}{dt} = 108\cos(46t - 9°)$





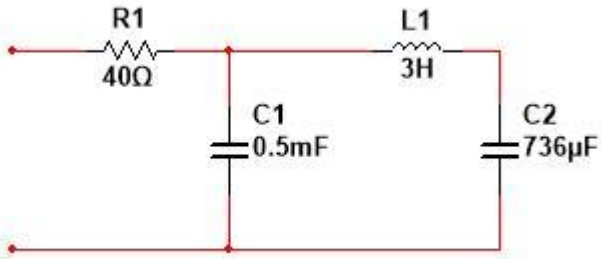




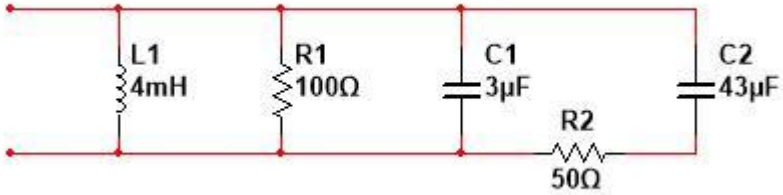
每小问2分，一共8分

4、Determine the equivalent impedance:

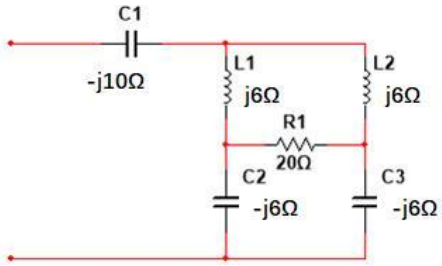
(a) ω=500rad/s



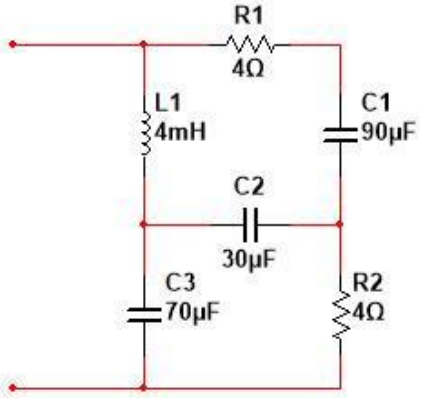
(b) f=2000Hz



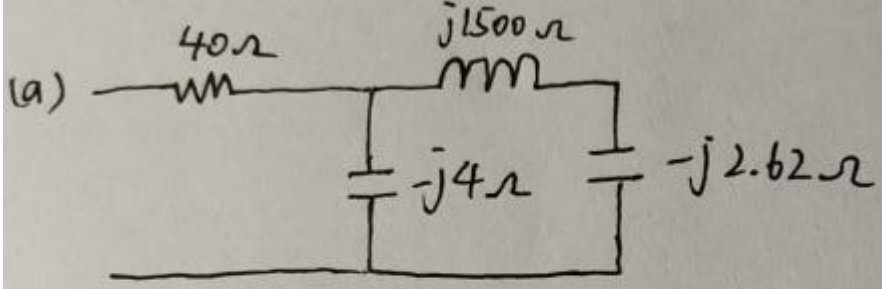
(c)



(d) ω=50000rad/s



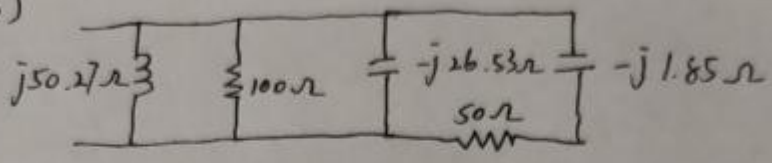
(a)



$$Z_{eq} = 40 + (-j4) // (j1500 - j2.62)$$

$$= 40 - j4.01 \quad \Omega$$

(b)

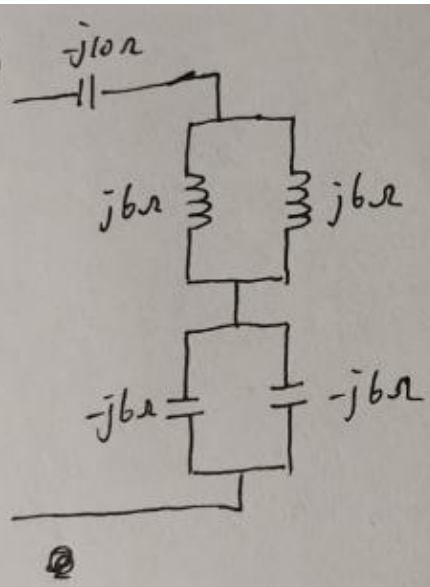


$$\omega = 2\pi f = 12566.37 \text{ rad/s}$$

$$Z_{eq} = j50.27 // 100 // (-j26.53) // (50 - j1.85)$$

$$= 24.13 - j14.93 \ \Omega$$

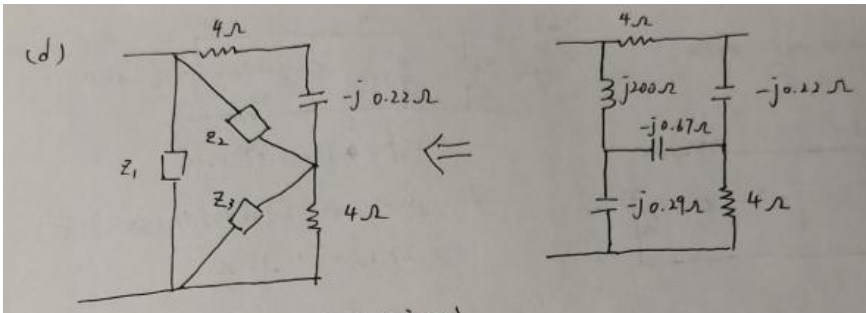
(c)



$$Z_{eq} = -j10 + j6 // j6 + (-j6) // (-j6)$$

$$= -j10\ \Omega$$

(d)



$$Z_1 = j200 - j0.29 + \frac{j200 \cdot (-j0.29)}{-j0.67} = j286.28\ \Omega$$

$$Z_2 = j200 - j0.67 + \frac{j200 \cdot (-j0.67)}{-j0.29} = j\,661.40\ \Omega$$

$$Z_3 = -j0.29 - j0.67 + \frac{(-j0.29)(-j0.67)}{j200} = -j\,0.96\ \Omega$$

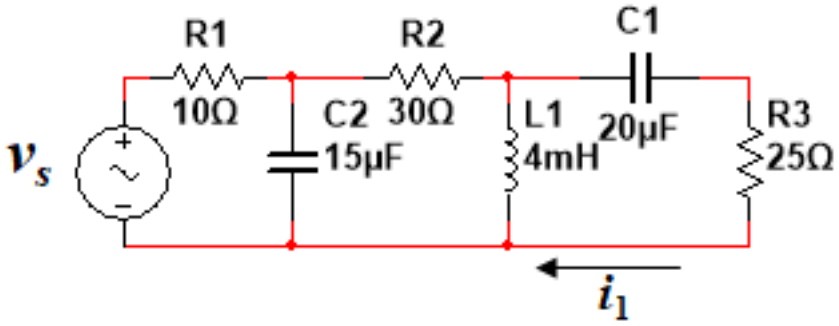
$$Z_{eq} = Z_1 // (Z_2 // (4 - j0.22) + Z_3 // 4)$$

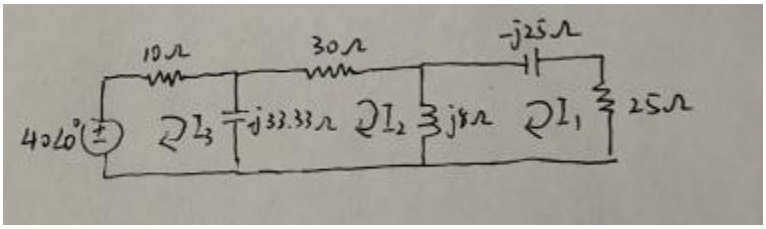
$$= Z_1 // (4.00 - j\,0.20 + 0.22 - j0.91)$$

$$= 4.25 - j1.04\ \Omega$$

每小问2分，一共8分

5、The circuit is operating in the sinusoidal steady state. Find $i_1(t)$ if $v_s(t)$ = 40cos(2000t) V





$$\begin{cases} -40\angle 0^\circ + I_3\,10 + (I_3 - I_2)\,j33.33 = 0 \\ -j33.33(I_2 - I_3) + 30I_2 + j8(I_2 - I_1) = 0 \\ 25I_1 + j8(I_1 - I_2) - j25I_1 = 0 \end{cases}$$

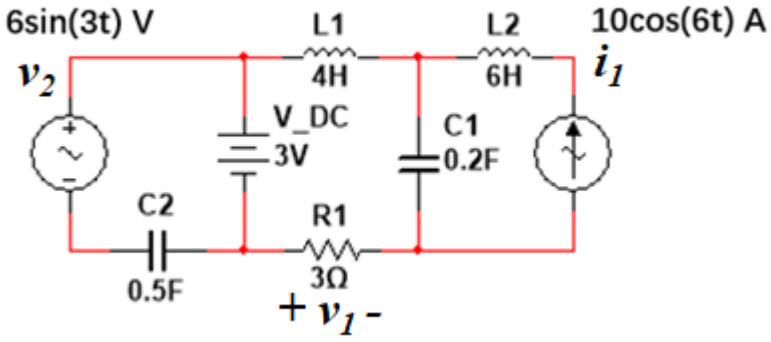
$I_1 = 0.24\angle 98.57^\circ$ A

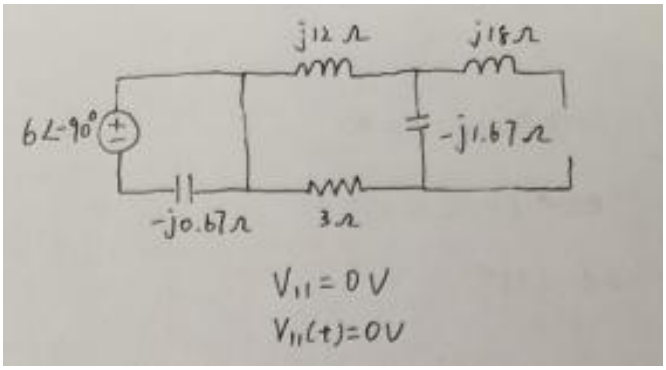
$i_2(t) = 0.24\cos(2000t + 98.57^\circ)$ A

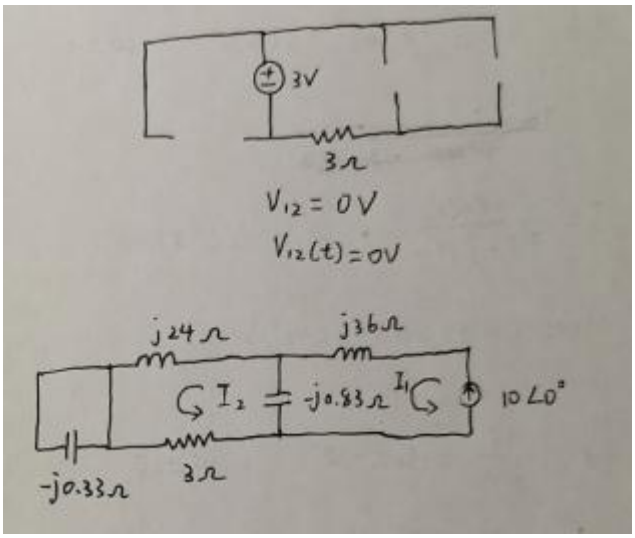
图片中最后一行写错，应将$i_2(t)$改为$i_1(t)$。

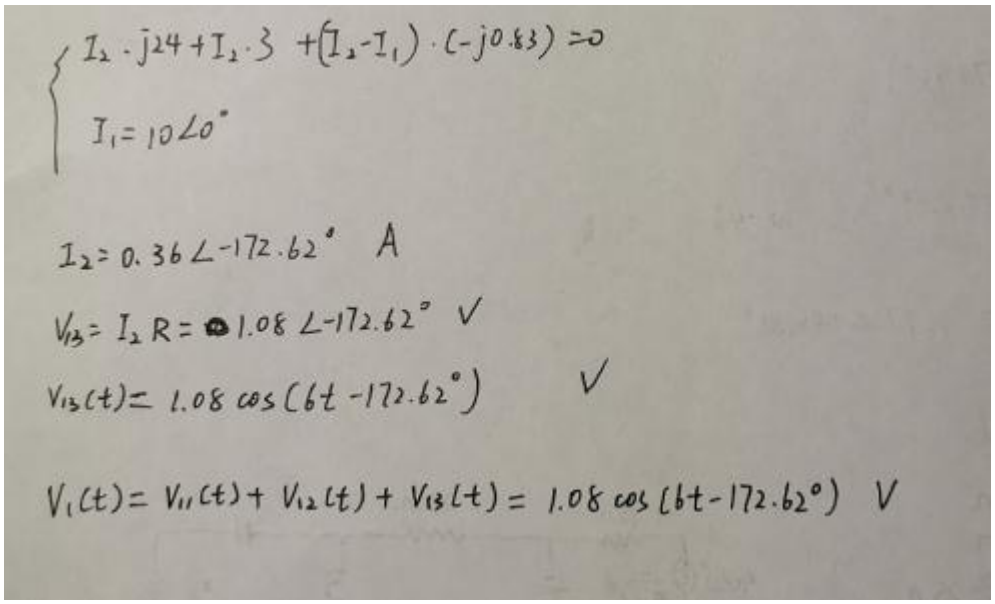
列出方程组3分，解出$I_1$4分，最后换成$i_1(t)$3分，一共10分

6、The circuit is operating in the sinusoidal steady state. Find v_1 in the circuit using superposition.



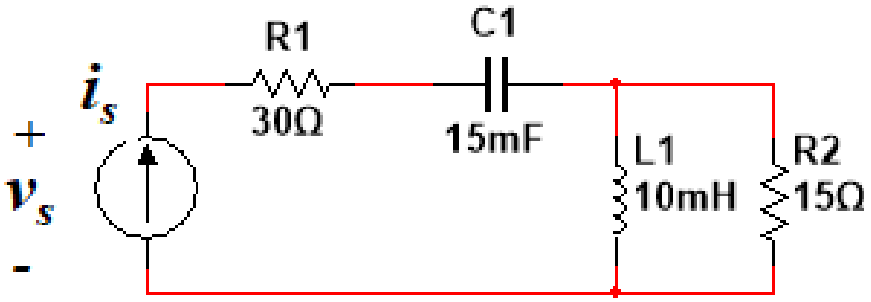


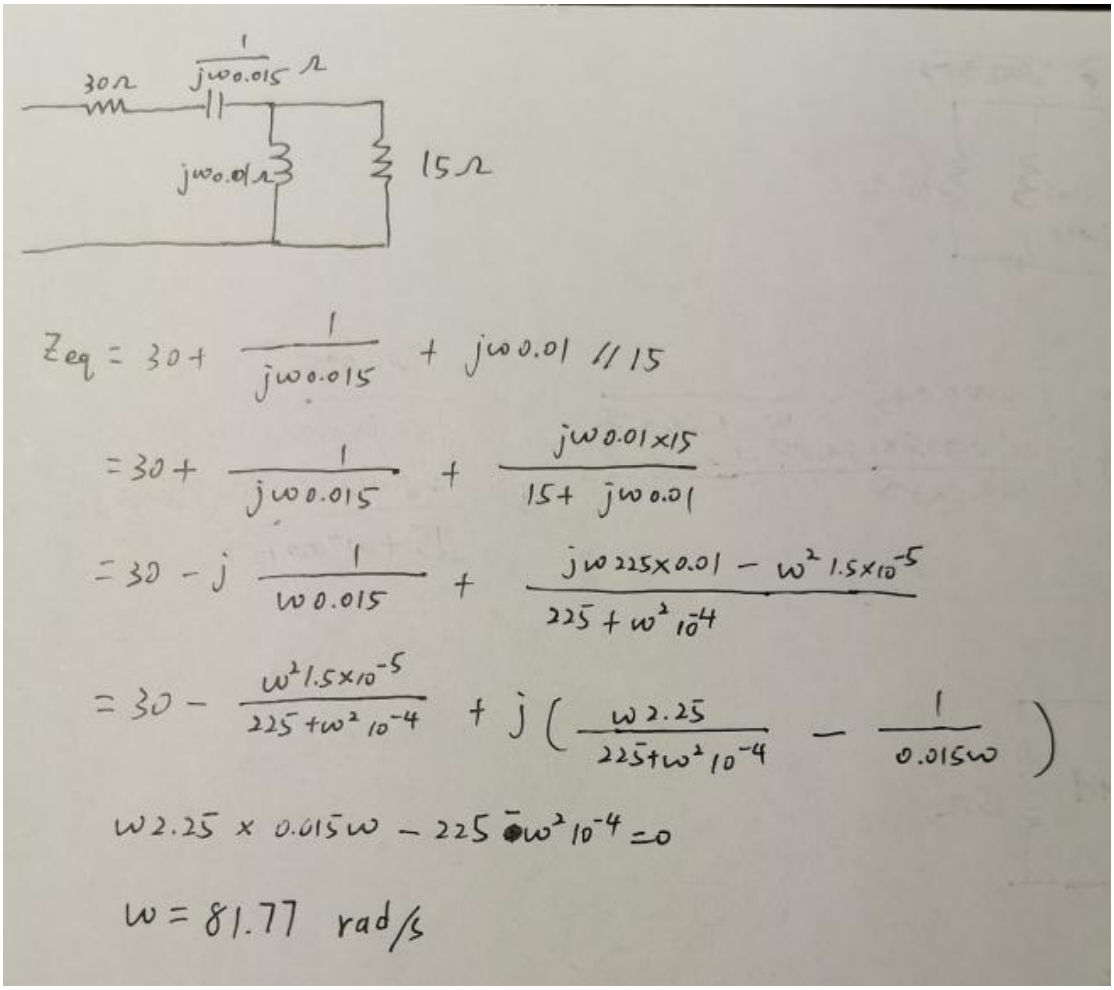




三个电源分别计算出的V_1各4分，最后得出总$V_1$3分，一共15分

7、Find the value of ω at which $v_s(t)$ and $i_s(t)$ in the circuit are in-phase (in-phase means that there is no imaginary part in the total Zeq).

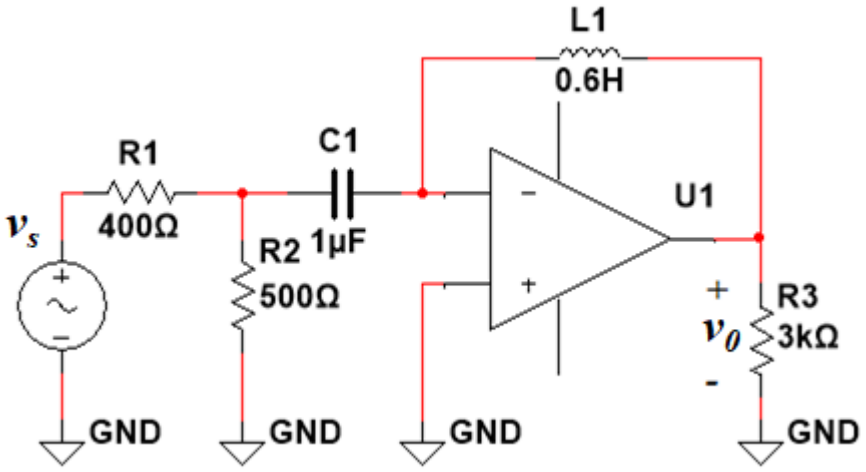


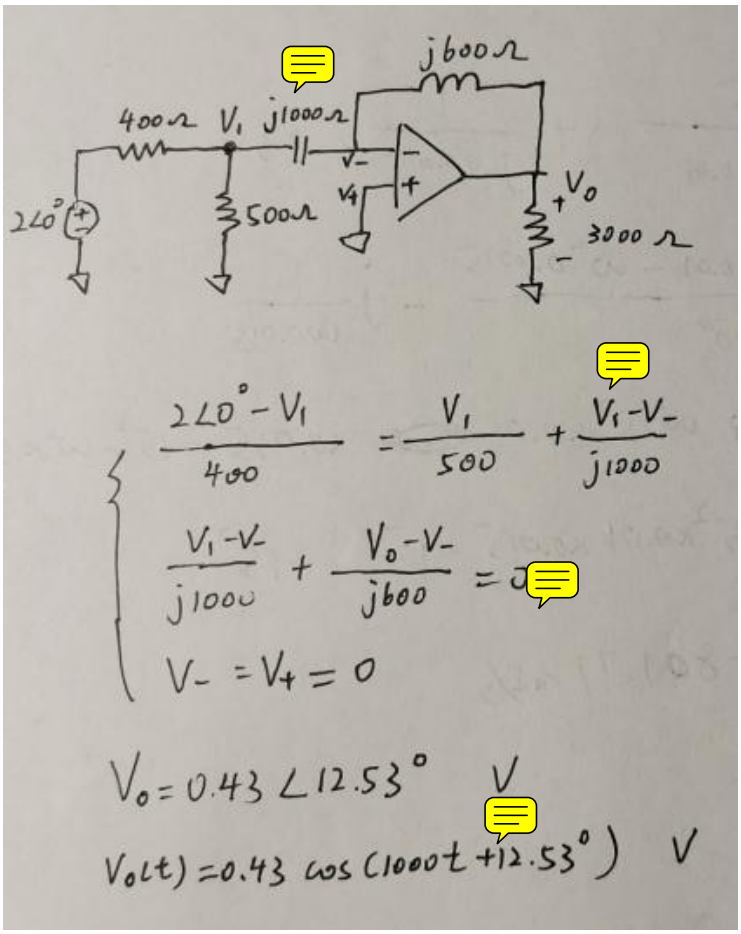


算出总的等效电阻的式子3分，列出方程3分，得到ω4分，一共10分。

8、The sinusoidal voltage source in the circuit is generating the voltage. If the op amp is ideal, what is the steady-state expression for $v_o(t)$?

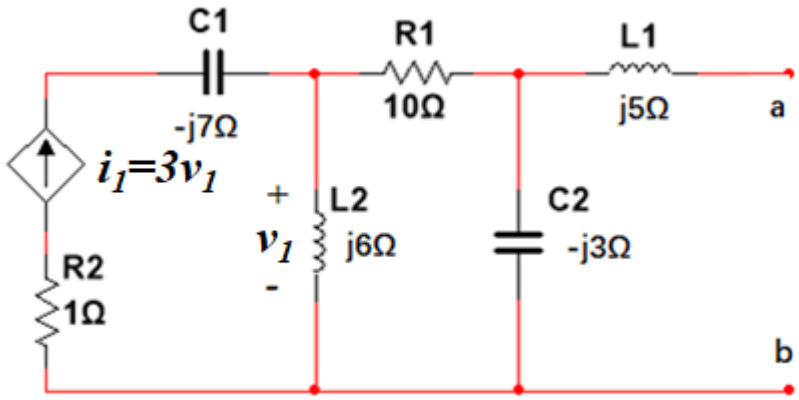
$v_s(t)=2\cos(1000t)$ V





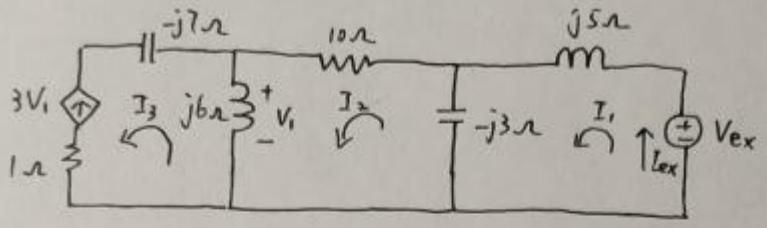
列出方程组3分，解出$V_0$4分，最后换成$v_0(t)$3分，一共10分

9、The circuit is in the phasor domain. Determine and plot its Thevenin equivalent circuit at terminals (a,b).



There is no independent source

$V_{Th} = 0\ V$



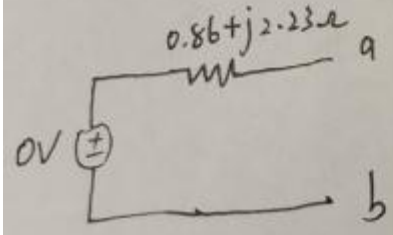
$$\begin{cases} I_1 = I_{ex} \\ -V_{ex} + I_1 \cdot j5 + (I_1 - I_2)\cdot(-j3) = 0 \\ (-j3)\cdot(I_3 - I_1) + I_2 \cdot 10 + V_1 = 0 \\ V_1 = (I_{02} - I_3)\cdot j6 \\ \text{[illegible]} \\ I_3 = -3V_1 \\ V_{ex} = 1 \end{cases}$$

$I_{ex} = 0.41 \angle -69.40^\circ \quad A$

$= 0.105 - j\,0.39 \quad A$

$$Z_{eq} = \frac{V_{ex}}{I_{ex}} = \frac{1}{0.15 - j0.39}$$

$= 0.86 + j2.23\ \Omega$



写出Vth3分，列出方程3分，解出流经外加电源的电流3分，算出等效阻抗3分，画图3分，一共15分。