台灣科技大學一百零七學年度上學期期中考

科目名稱：電路學(一)　開課系所：電子系 ET2103301　地點：國際大樓 IB501

考試時間：107 年 11 月 08 日　下午 13:20 至 15:10 (雙面試題，不可使用工程計算機)

1. (25%) Consider an OP-AMP circuit in Fig. 1. (a) Please determine the relation between the output voltage and the input voltages. (10%) (b) If $1V \le V_1 \le 2V$ and $2V \le V_2 \le 3V$, please determine the range of V_o. (5%) (c) Whether this circuit will produce the full range of V_o given that the dc supplies are $\pm 10V$. If the answer is no, what is the practical output range of V_o. (10%)

(a)
$8V_1 - 4V_2$
(b)
$-4V \le V_0 \le 8V$
(c)
$-2V \le V_0 \le 2V$

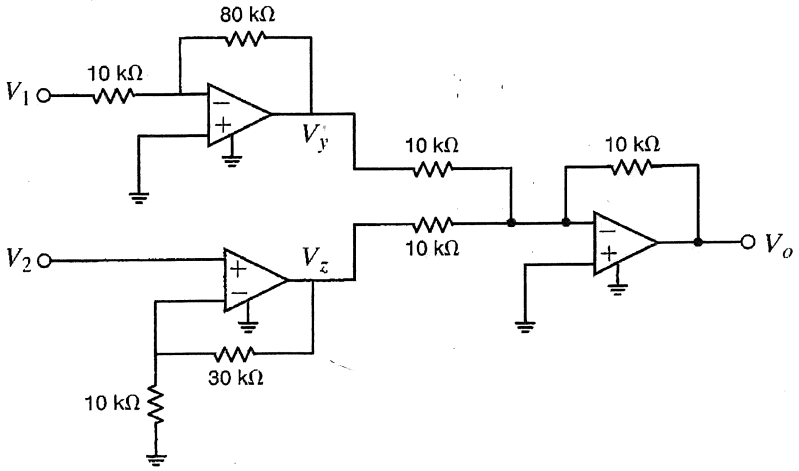

Fig. 1.

2. (15%) Please find R_L for maximum power transfer and the maximum power transferred to this load in the following circuit.

9075w

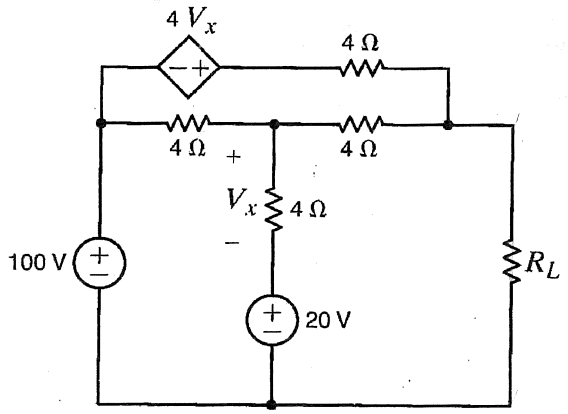

Fig. 2.

3. (15%) Please calculate I_o in Fig. 3.

−48mA

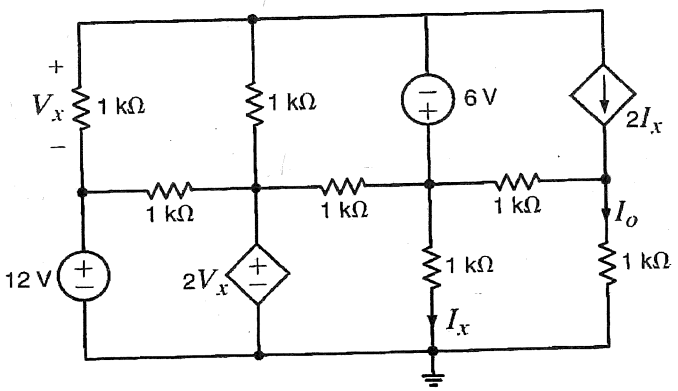

Fig. 3.

4. (15%) Please calculate V_o in Fig. 4 by using Norton's theorem.

$\frac{-8}{9}$V

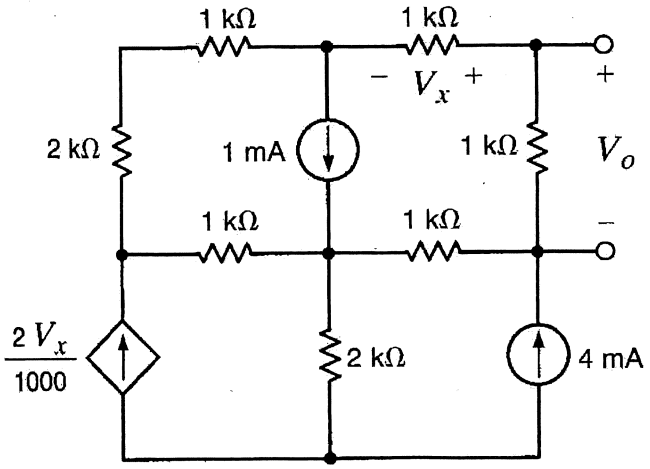

Fig. 4.

5. (15%) Please find the total energy stored in the circuit as shown in Fig. 5.

13.4604mJ

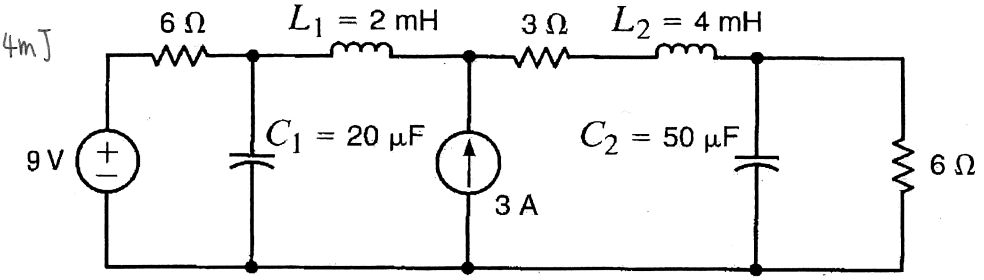

Fig. 5.

6. (15%) Please derive the expression of the output voltage v_o in Fig. 6. (a) What is the output voltage expressed by the input sources v_{s1} and v_{s2}? (10%) (b) If the sources are given as $v_{s1} = 80\cos 377t$ and $v_{s2} = 40\cos 377t$, what is the value of the output voltage? (5%)

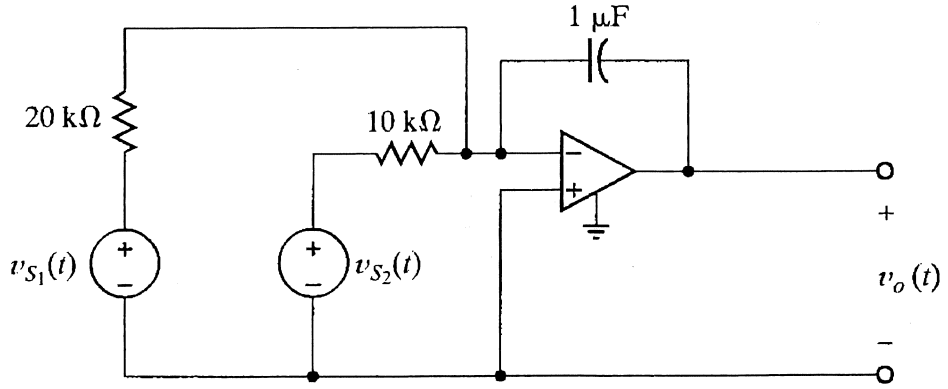

Fig. 6.

(a)

$V_o = -50\int(V_{s1}+2V_{s2})\,dt$

(b)

$V_o = -21.2\sin 377t\,V$

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1. $V_y = V_1 \times (-\frac{80k}{10k}) = -8V_1$, $V_z = V_2 \times (1 + \frac{30k}{10k}) = 4V_2$

(a) $V_o = (-8V_1) \times (-\frac{10k}{10k}) + (4V_2) \times (\frac{10k}{10k}) = 8V_1 - 4V_2$ #

(b) $1V \le V_1 \le 2V$ $V_o = 0V, -4V, 8V, 4V$

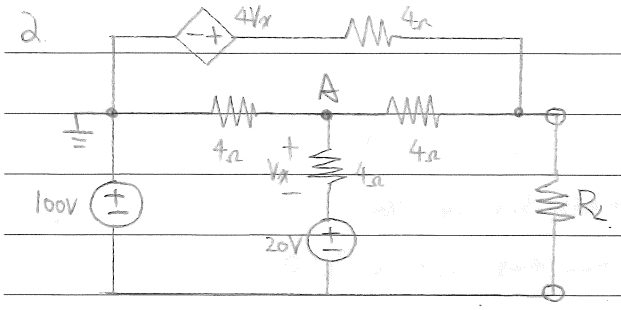
$2V \le V_2 \le 3V$

$-4V \le V_o \le 8V$ #

(c) $V_y = -8V_1$, $-10V \le V_y \le -8V$

$V_z = 4V_2$, $8V \le V_z \le 10V$ $-2V \le V_o \le 2V$ #

2.



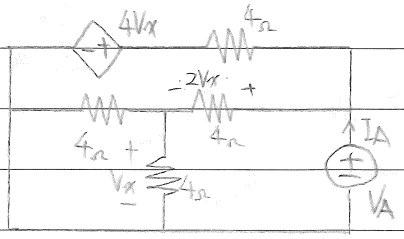
轉移

最大功率 R_L 和最大功率

$\frac{A-4V_x}{8} + \frac{A}{4} + \frac{A+80}{4} = 0 \Rightarrow 5A - 4V_x = -160$

$\frac{A+80}{4} \times 4 = V_x \Rightarrow A - V_x - 80$, $V_x = 240V$, $A = 160V$

$-(\frac{-160-960}{8} \times 4) + 240 + 20 = 660\,V = V_{th}$



$V_A = 8V$

$V_x = 1V$

$I_A = \frac{3-4}{4} + \frac{3}{6} = \frac{-1}{4} + \frac{1}{2} = \frac{1}{4}$

$\frac{V_A}{I_A} = 12\,\Omega$ #

$P_{MAX} = \frac{1}{4}(660)^2/12 = 9075\,W$ #

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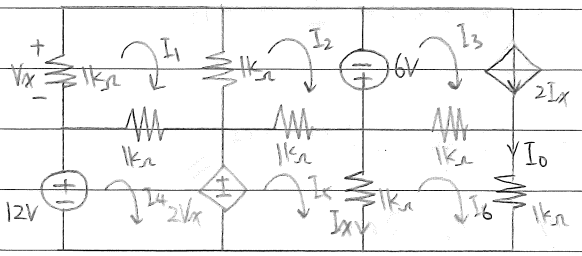
3.



find I_0

$2I_x = I_3 = 2I_5 - 2I_6$

$2I_x = I_3$, $I_x = I_5 - I_6$, $V_x = -I_1$

$V_x = 2I_1 - I_2 - I_4 \Rightarrow 3I_1 - I_2 - I_4 = 0$

$-6 = 2I_2 - I_1 - I_5 \Rightarrow I_1 - 2I_2 + I_5 = -6 \Rightarrow I_1 = -6 + 2I_2 - I_5$

$12 = I_4 - I_1 + 2V_x \Rightarrow 3I_1 - I_4 = -12$

$2V_x = 2I_5 - I_2 - I_6 \Rightarrow 2I_1 - I_2 + 2I_5 - I_6 = 0$

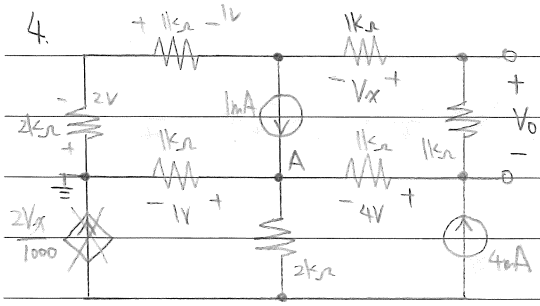
$0 = 3I_6 - I_3 - I_5 \Rightarrow I_3 + I_5 - 3I_6 = 0$

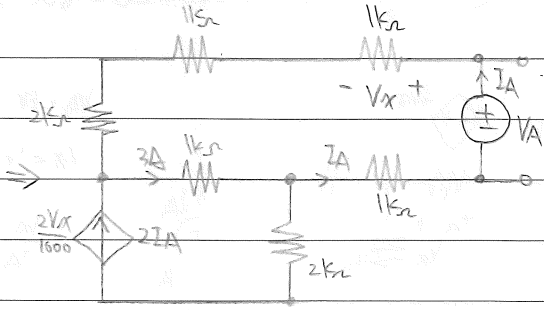
$$\begin{cases} 3I_1 - I_2 - I_4 = 0 \\ 3I_1 - I_4 = -12 \\ 2I_1 - I_2 + 2I_5 - I_6 = 0 \\ I_3 + I_5 - 3I_6 = 0 \end{cases} \Rightarrow \begin{cases} -18 + 6I_2 - 3I_5 - I_2 - I_4 = 0 \\ -18 + 6I_2 - 3I_5 - I_4 = -12 \\ -12 + 4I_2 - 2I_5 - I_2 + 2I_5 - I_6 = 0 \\ I_3 + I_5 - 3I_6 = 0 \end{cases}$$

$$\Rightarrow \begin{cases} 5I_2 - I_4 - 3I_5 = -18 \\ 6I_2 - I_4 - 3I_5 = -6 \\ 3I_2 - I_6 = 12 \\ I_3 + I_5 - 3I_6 = 0 \end{cases}$$

$I_2 = -12mA$, $I_6 = -48mA$ #

4.

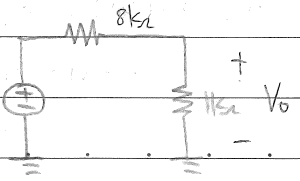




$V_x = 1k \cdot 2A$, $V_A = 8V_x$

$\frac{V_A}{I_A} = \frac{8V_x}{\frac{V_x}{1k}} = 8k\Omega$

$V_{th} = -8V$



$V_0 = -8 \times \frac{1k}{9k} = \frac{-8}{9} V$ #

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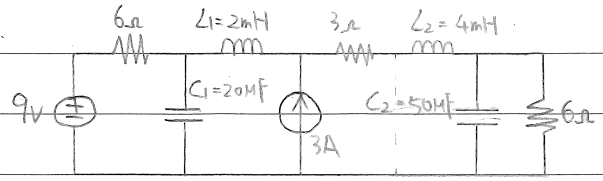
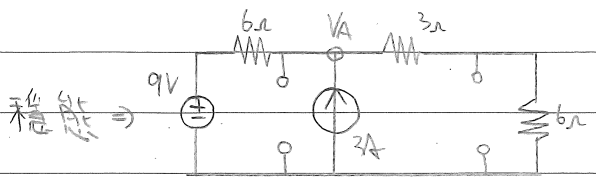
5.



Find total energy



$\frac{9-V_A}{6} + 3 = \frac{V_A}{9} \Rightarrow 27 - 3V_A + 54 = 2V_A$

$\Rightarrow 5V_A = 81 \Rightarrow V_A = 16.2V$

$I_{L1} = (9-16.2)/6 = -1.2A$

$I_{L2} = 1.8A$

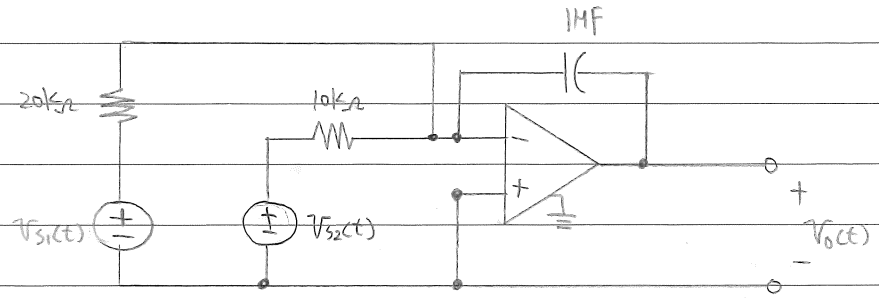
$V_{C1} = 6\times1.2 + 9 = 16.2V$

$V_{C2} = 16.2 - 1.8\times3 = 10.8V$

$E = \frac{1}{2}(1.2^2\times2m + 1.8^2\times4m + 16.2^2\times20M + 10.8^2\times50M)$

$= 13.46mJ$ #

6.



(a) $\frac{V_{S1}(t)}{20k} + \frac{V_{S2}(t)}{10k} = C\frac{dV}{dt} \Rightarrow V_{S1}(t) + 2V_{S2}(t) = -20m\frac{dV_o(t)}{dt}$

$\Rightarrow \int(V_{S1}(t) + 2V_{S2}(t))dt = -20m\int\frac{dV_o(t)}{dt}dt$

$\Rightarrow V_o(t) = -50\int(V_{S1}(t) + 2V_{S2}(t))dt$

(b) $V_o(t) = -50\int 160\cos 3\pi t\, dt$

$= -50\times160\times\frac{1}{3\pi}(\sin3\pi t) = -21.22\sin3\pi t\ (V)$ #