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 $1V \leq V_1 \leq 2V$ and $2V \leq V_2 \leq 3V$, 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)
$8V_1 - 4V_2$
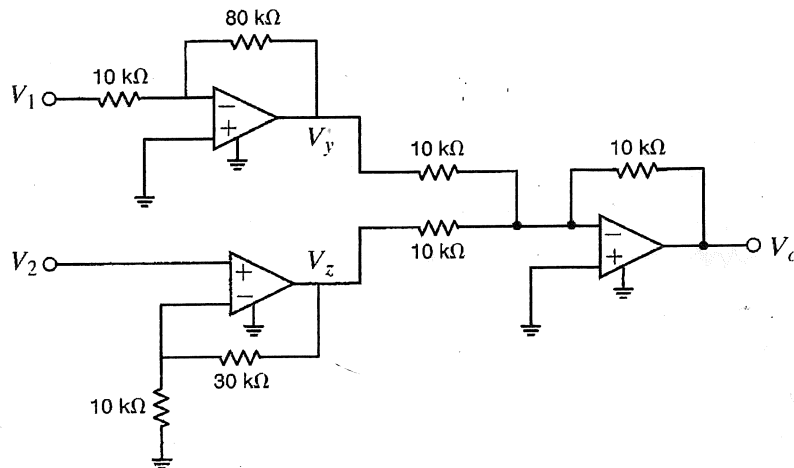(b)
$-4V \leq V_o \leq 8V$
(c)
$-2V \leq V_o \leq 2V$

Fig. 1.

2. (15%) Please find R_L for maximum power transfer and the maximum power transferred to this load in the following circuit.
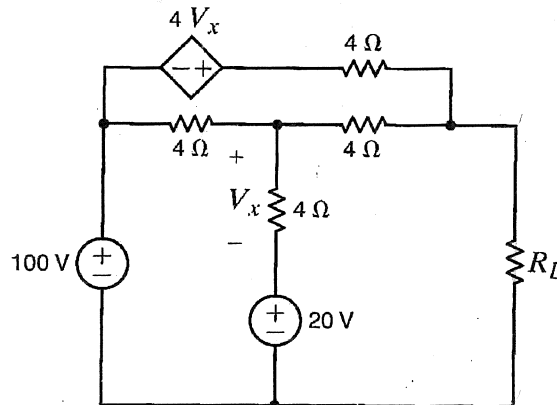
$90.75w$

Fig. 2.
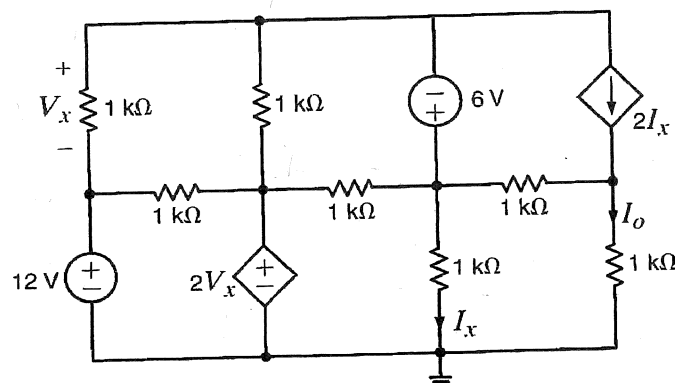
3. (15%) Please calculate I_o in Fig. 3.

$-48mA$

Fig. 3.

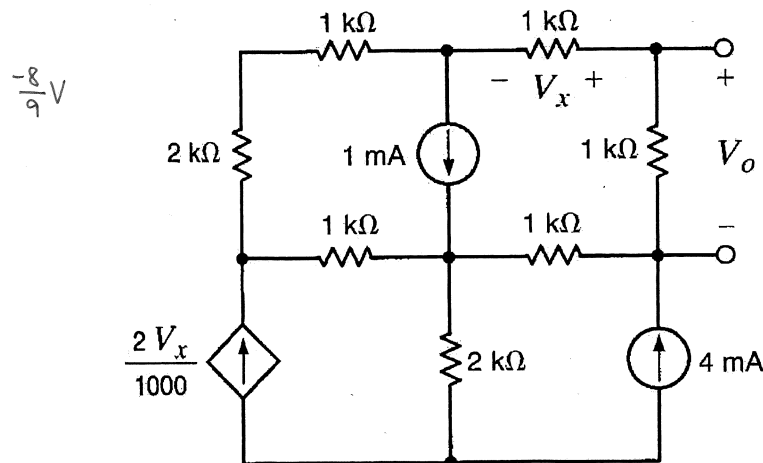4. (15%) Please calculate V_o in Fig. 4 by using Norton's theorem.

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

1 kΩ		1 kΩ
2 kΩ	1 mA	$-V_x+$ 1 kΩ V_o
1 kΩ		1 kΩ

$\frac{2V_x}{1000}$ 2 kΩ   4 mA

Fig. 4.

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

13.4604mJ

6 Ω $L_1 = 2$ mH   3 Ω $L_2 = 4$ mH

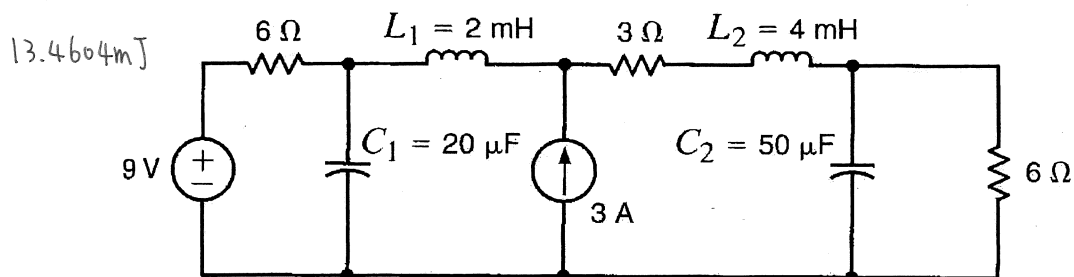9 V $C_1 = 20$ μF   3 A $C_2 = 50$ μF   6 Ω

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 $v_{s1} = 80 \cos377t$ and $v_{s2} = 40 \cos377t$, what is the value of the output voltage? (5%)
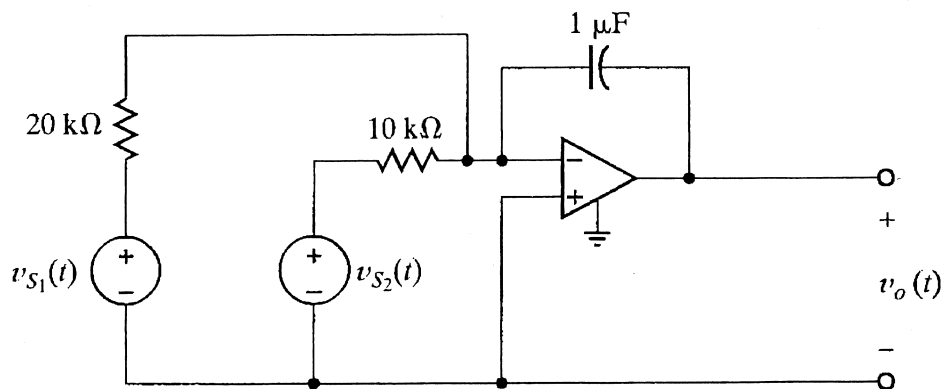
1 μF

20 kΩ   10 kΩ

$v_{S_1}(t)$ $v_{S_2}(t)$ $v_o(t)$

(a)   Fig. 6.

$V_0 = -50 \int (V_{s1}+2V_{s2})\,dt$

(b)

$V_0 = -21.2\sin3\pi7t\,V$