第 2 講:RC 電路(時域分析)

參考文獻與網頁:

[1]蕭敏學，大學電子學實習(一):電子電路分析篇，台科大圖書，2013
[2]YouTube: 吳順德，應用電子電實驗(l3 RC 電路)，
https://www.youtube.com/watch?v=2ZI7DckPalA&list=PLXxs-fSMcpYfBBswuFSBfefLbeBmOUbZ2&index=3

一、教學過程: 請參考[2]

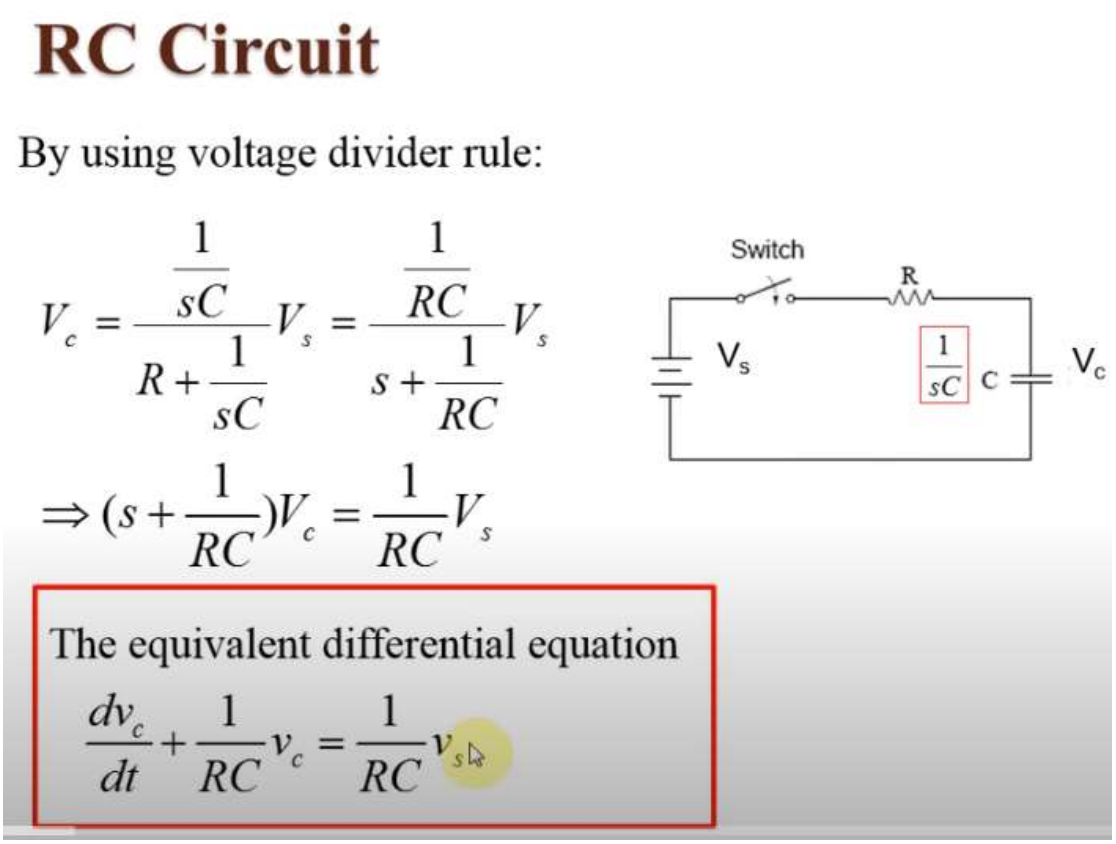


圖 2-1 RC 電路

First order differential equation

$$\frac{dy}{dt}+\frac{1}{\tau}y=K$$

homogeneous solution $y_h(t)=Ae^{-\frac{t}{\tau}}$

particular solution $y_p(t)=B$

Substitution Initial value and Final value condition into equation

$$y(0)=y_h(0)+y_p(0)=A+B\cdots\cdots(1)$$

$$y(\infty)=y_h(\infty)+y_p(\infty)=B\cdots\cdots(2)$$

$$(1)-(2)\Rightarrow A=y(0)-y(\infty)$$

Solution

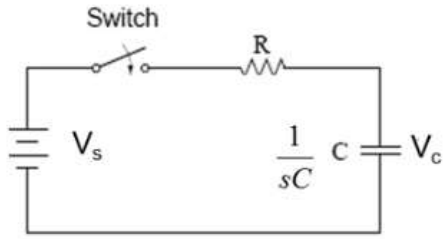
$$y(t)=y_p(t)+y_h(t)=y(\infty)+(y(0)-y(\infty))e^{-\frac{t}{\tau}}$$

圖 2-2　一階微分方程式

Time Response for RC circuit

Initial and final value

$$\frac{dv_c}{dt}+\frac{1}{RC}v_c=\frac{1}{RC}v_s$$



$$\begin{cases}v_c(0)=v_0\\ v_c(\infty)=v_s\end{cases}$$

$$v_c(t)=v_s+(v_0-v_s)e^{-\frac{t}{\tau}}$$

where $\tau=RC$

圖 2-3　RC 電路時間反應

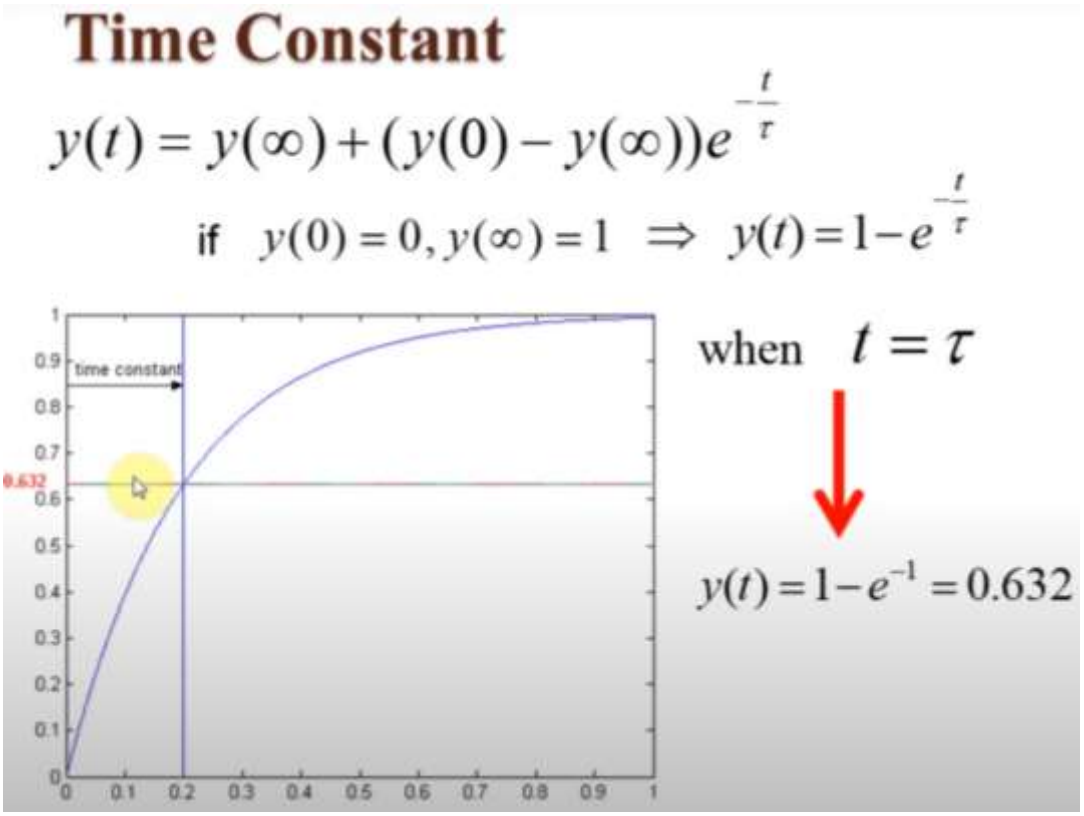


圖 2-4 RC 電路時間常數

二、RC 電路時域分析，請參考[2]

- 建立 RC 電路如下圖(圖 2-5)

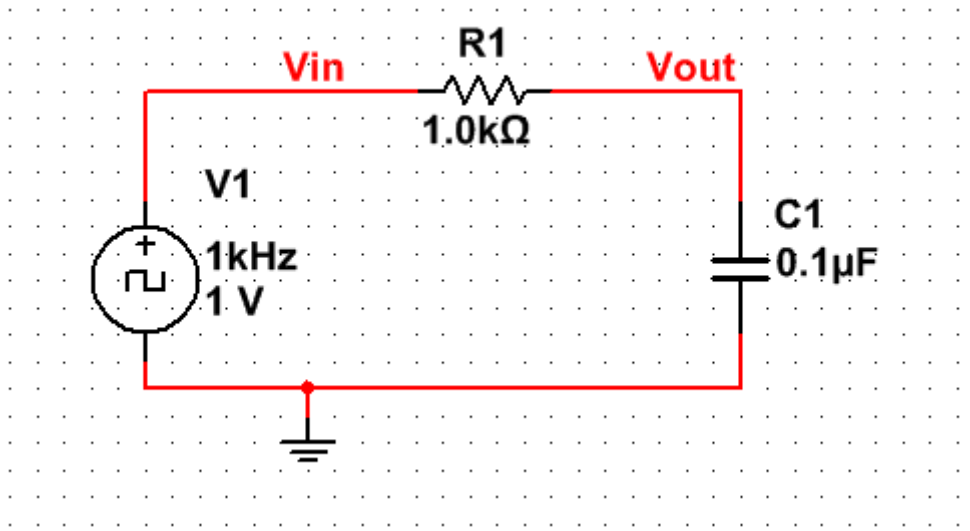
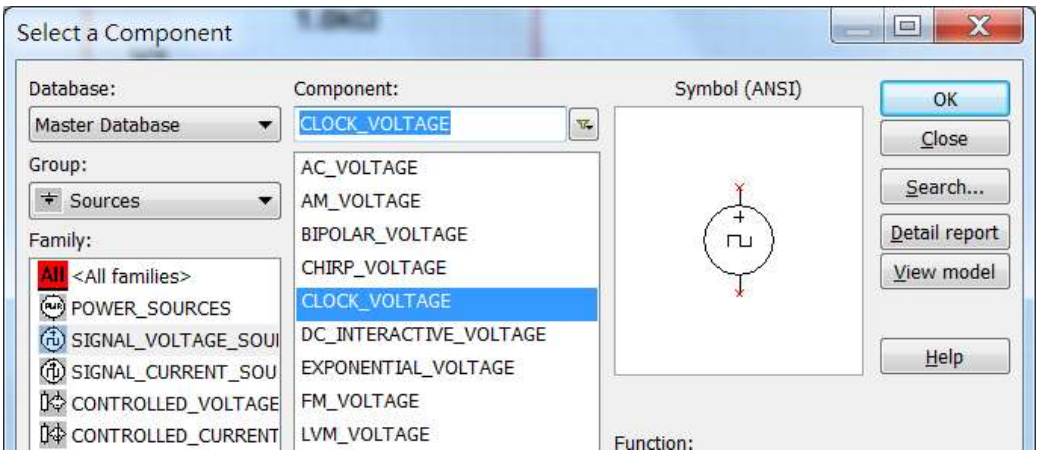


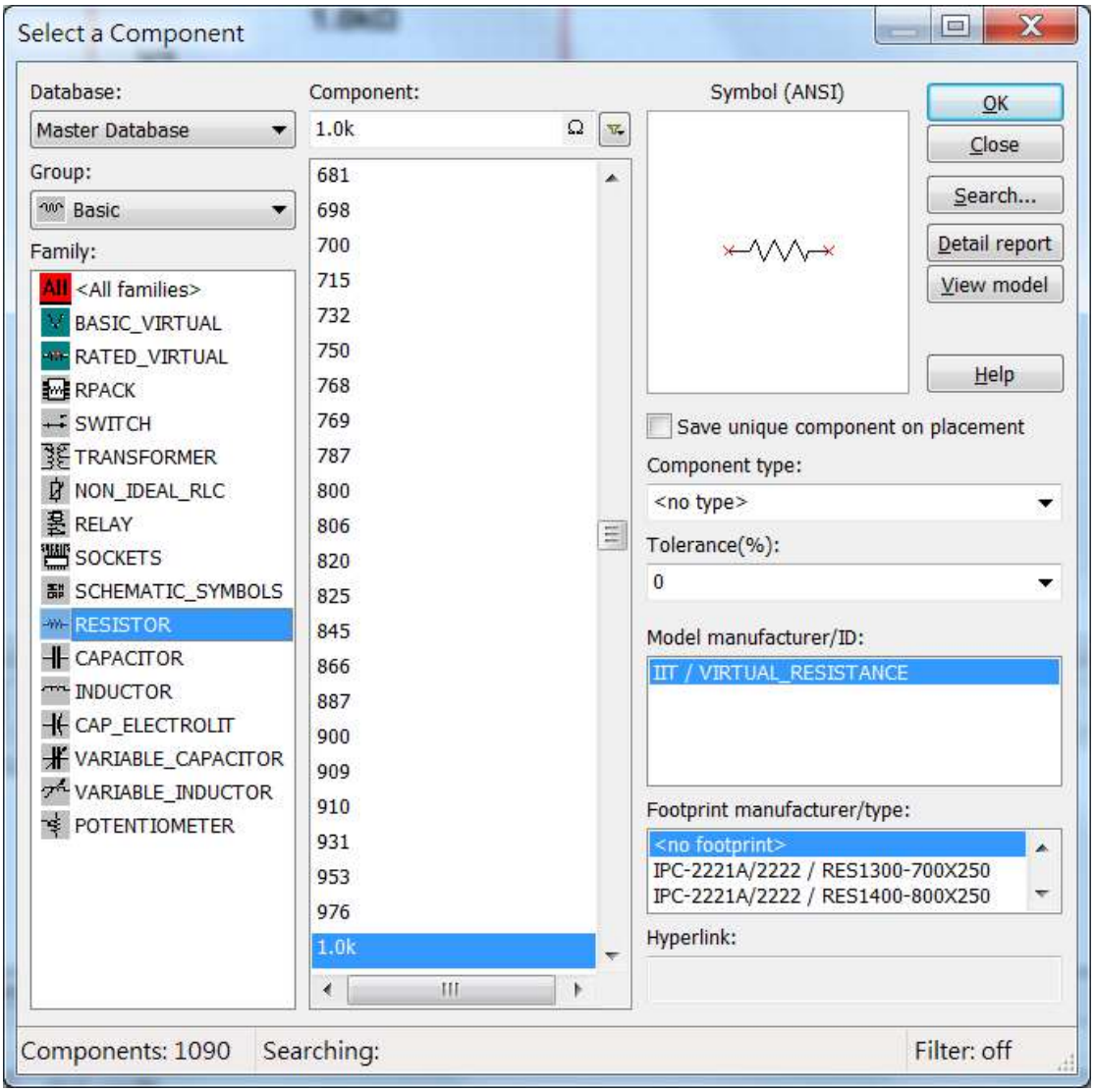
圖 2-5 RC 電路

- 方波訊號源:

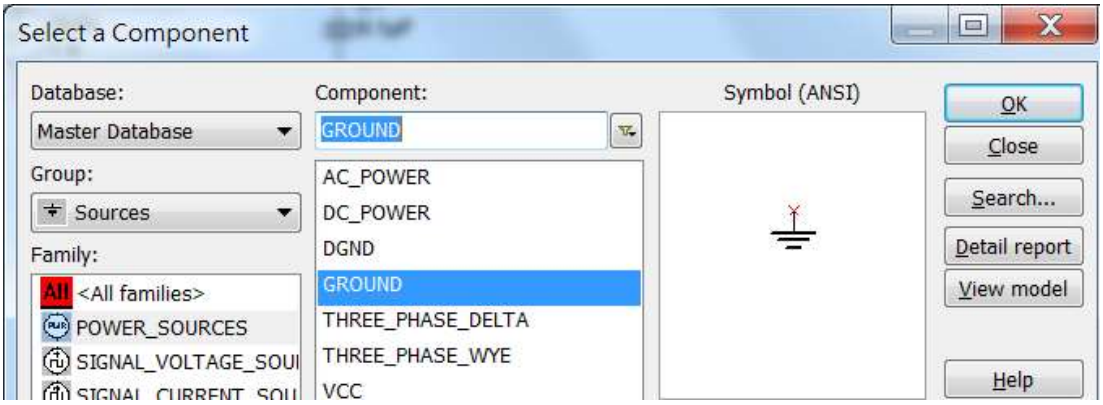
Place→Component→Sources→SIGNAL_VOLTAGE_SOURCES→CLOCK_VOLAGE



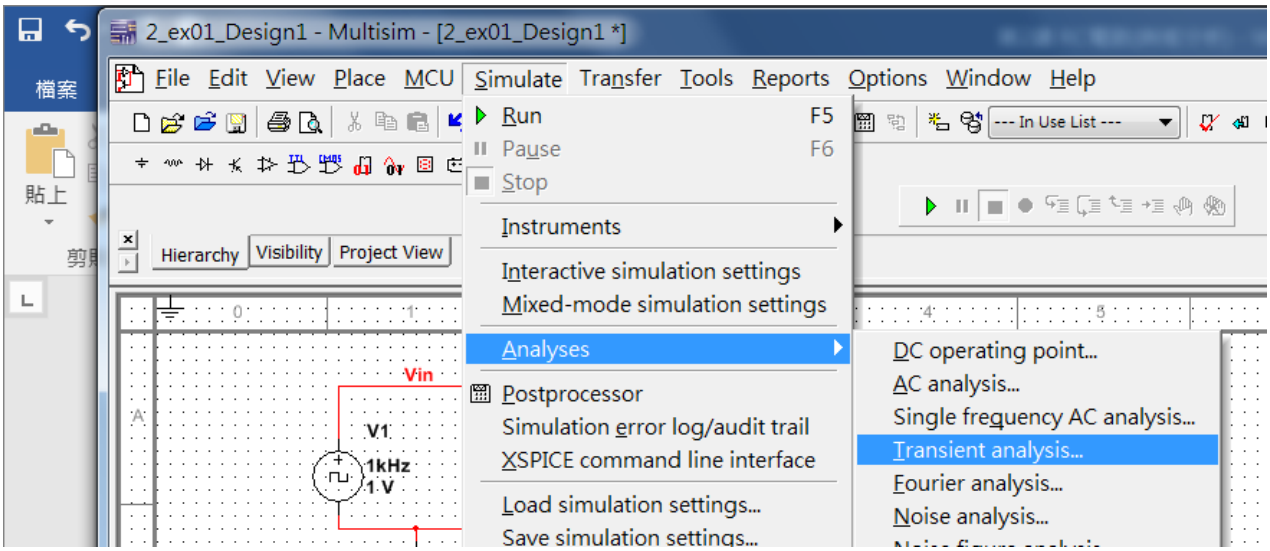
- 電阻: Place→Component→Basic →RESISTOR →1.0K

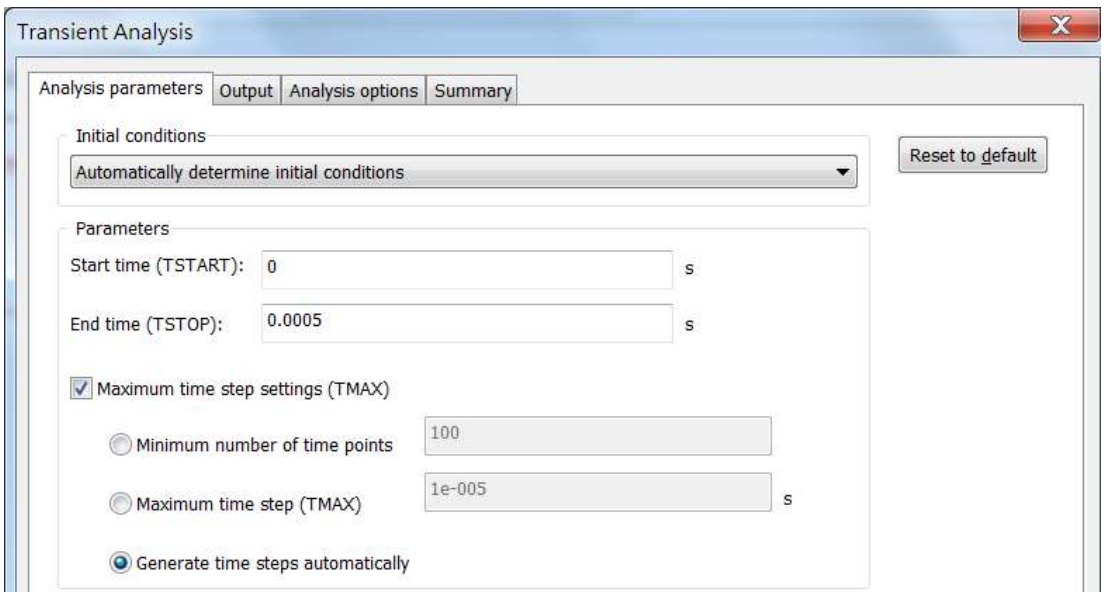


- 電容: Place→Component→Basic →CAPACITOR →1.0U (隨後修改為 0.1 UF)
- 接地: Place→Component→Sources→POWER_SOURCES→GROUND

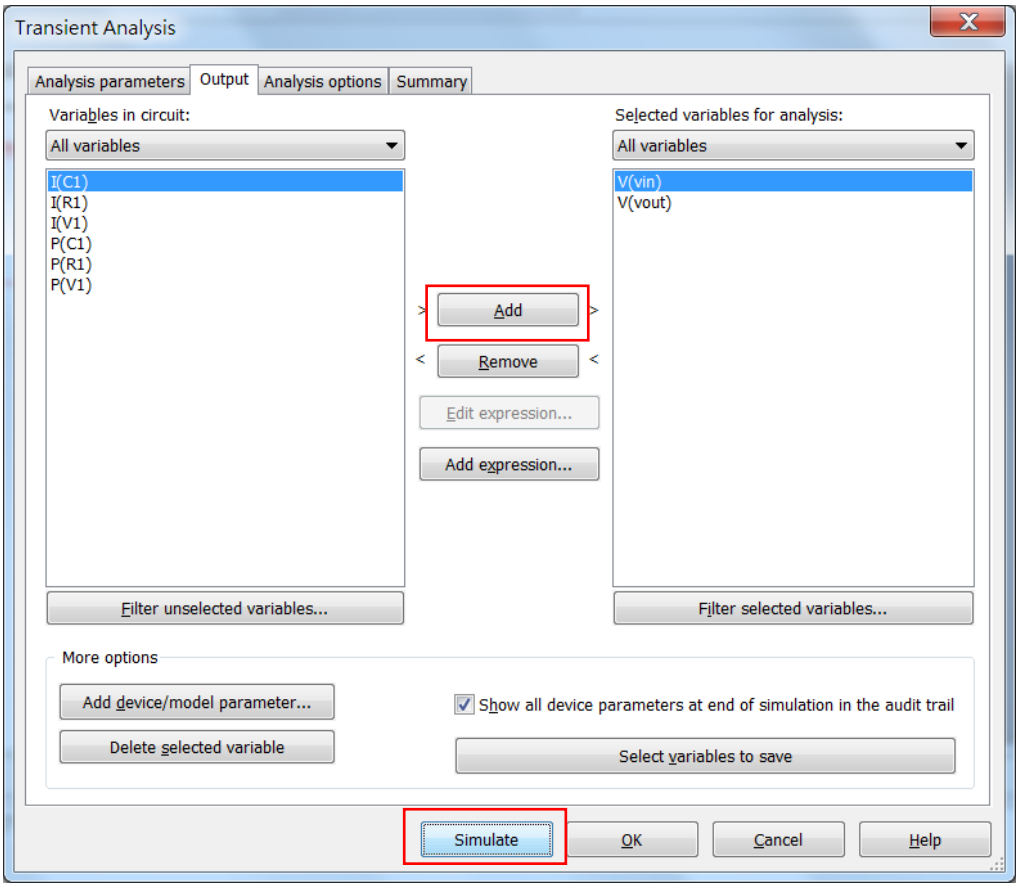


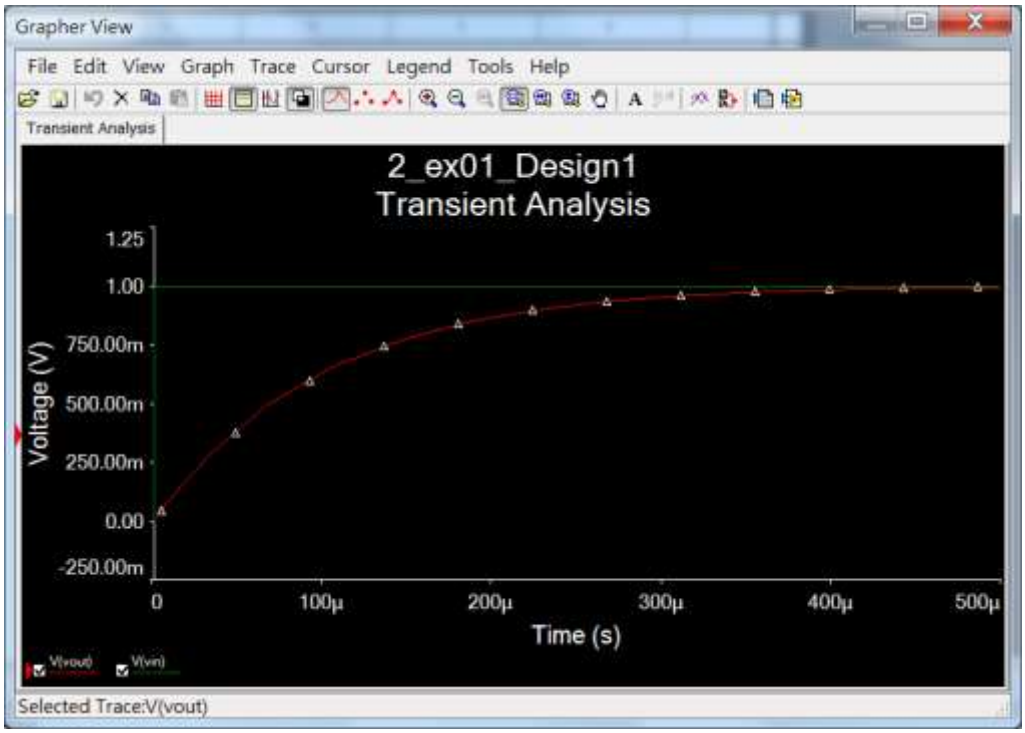
- 暫態分析設定



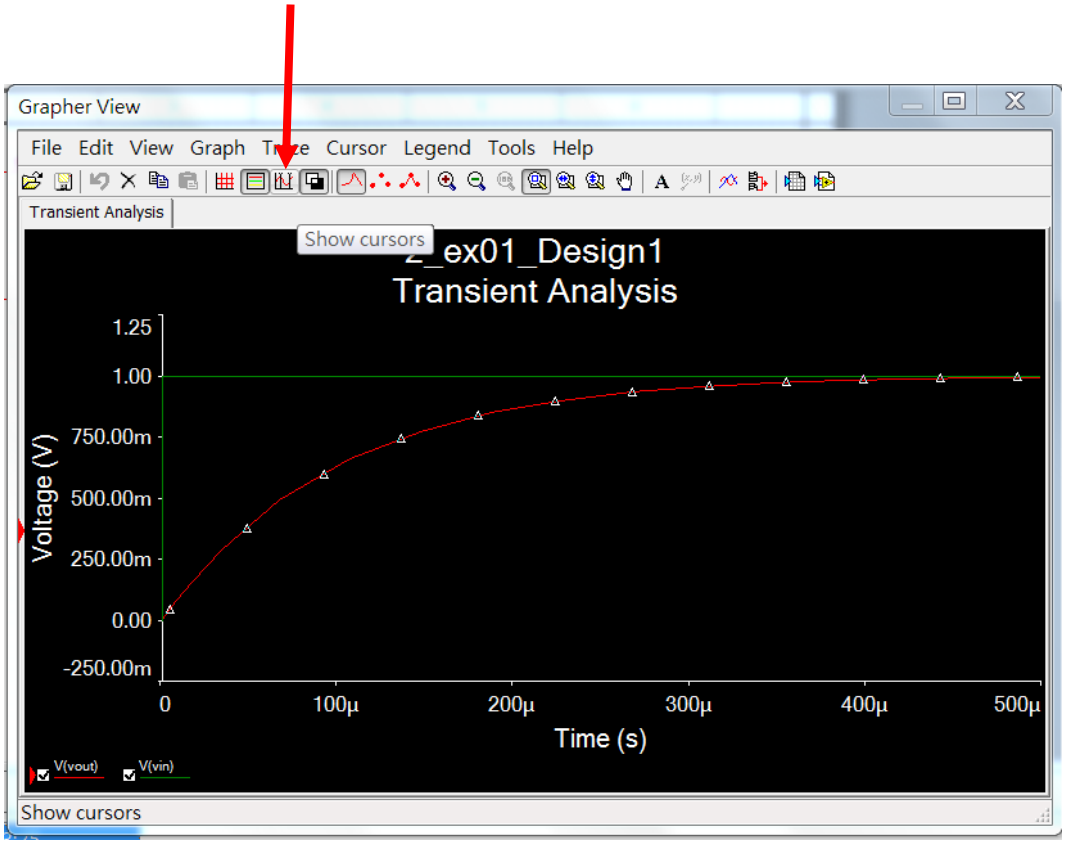


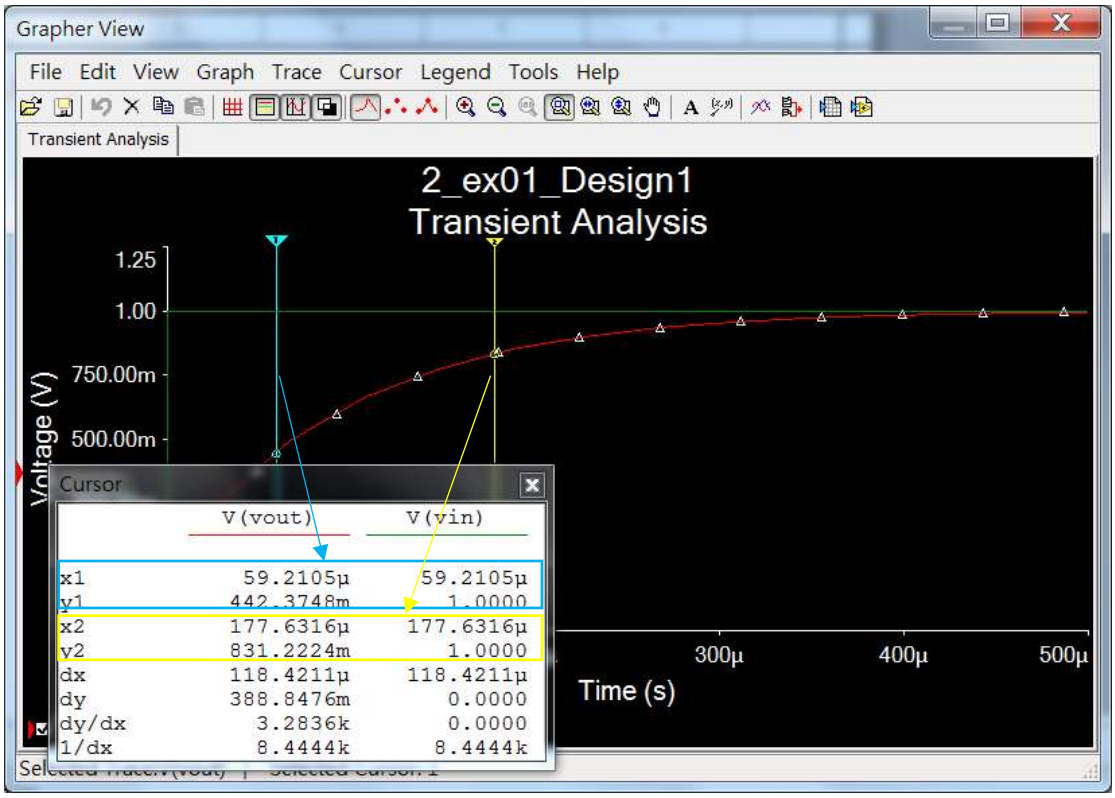
Add V(vin), V(vout)，隨後 Simulate



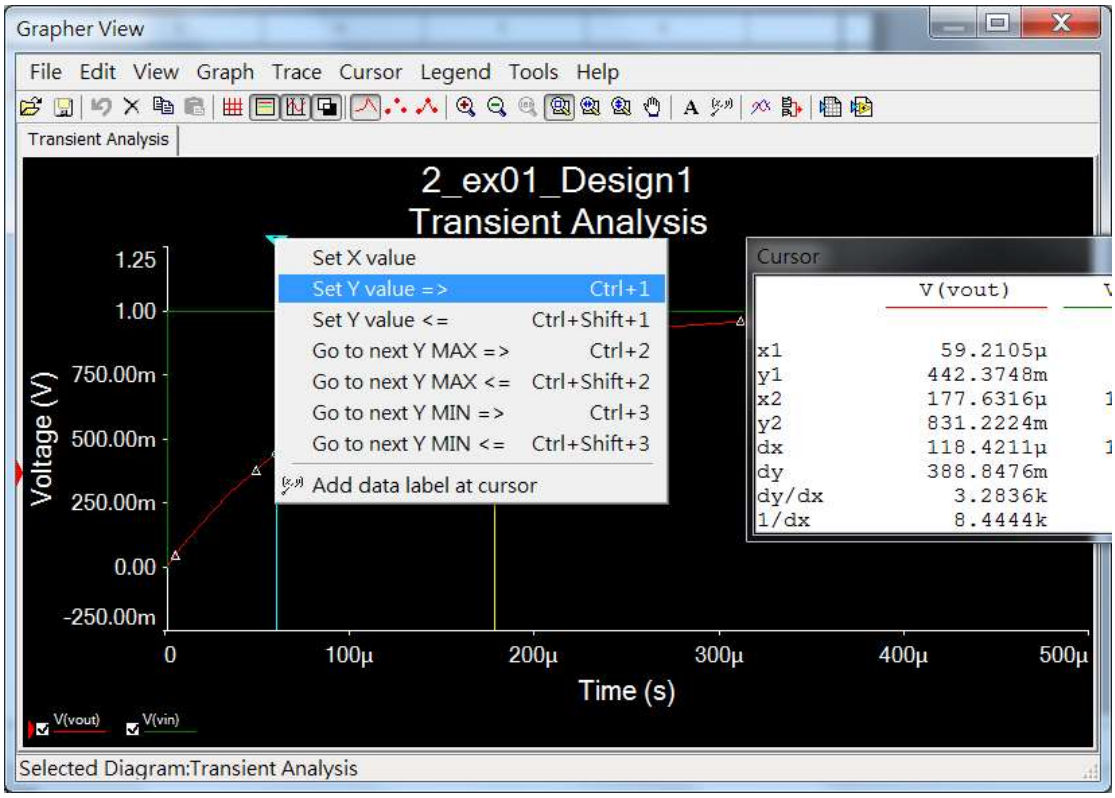


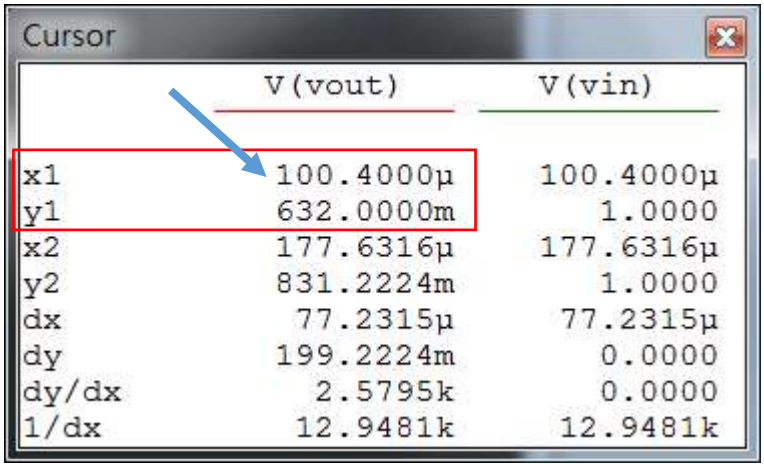
使用“Show cursors”測量各點數值





針對 cursors 1，按下右鍵，為找 0V 升到 0.632V 的時間，選 Set Y value => 0.632





X1 = 100.4us = (近似於) 1.0 k * 0.1u = 1000x 0.000001 = 0.001 = R * C (time

constant, 時間常數)

三、

- 作業 2-1:
  1. 完成下圖(圖 2-6A)
  2. 請推導 Vout 的數學式，如圖 2-6B

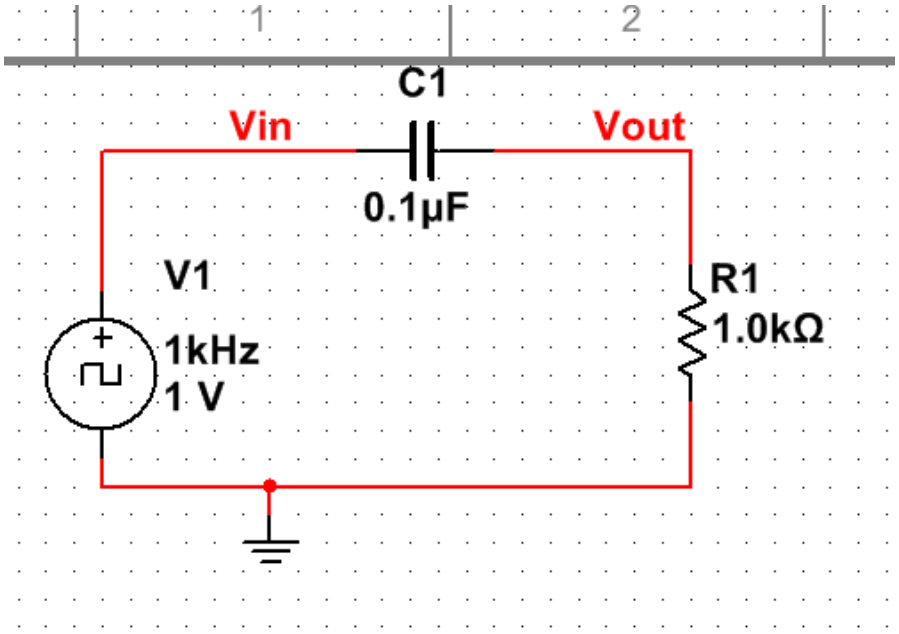


圖 2-6A　作業 2-1 電路

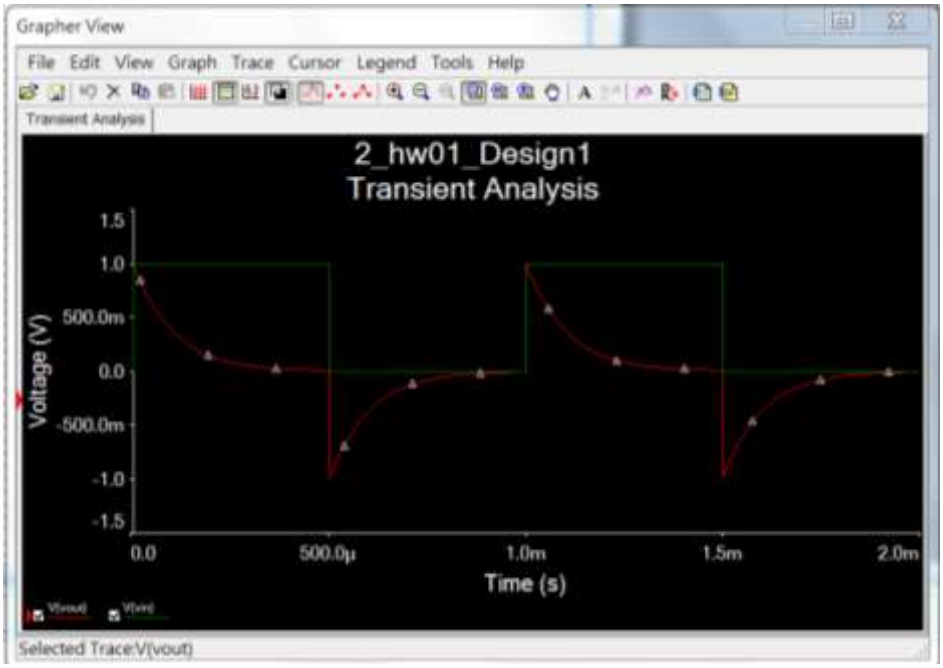


圖 2-6B　作業 2-1 Vout 波形

- 作業 2-2:
  1. 完成下圖(圖 2-7A)
  2. 請推導 Vout 的數學式，如圖 2-7B

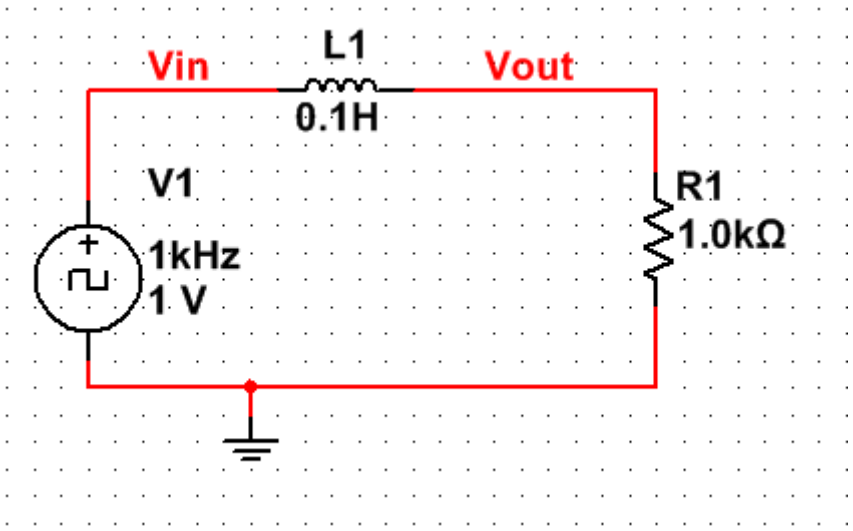


圖 2-7A 作業 2-2 電路

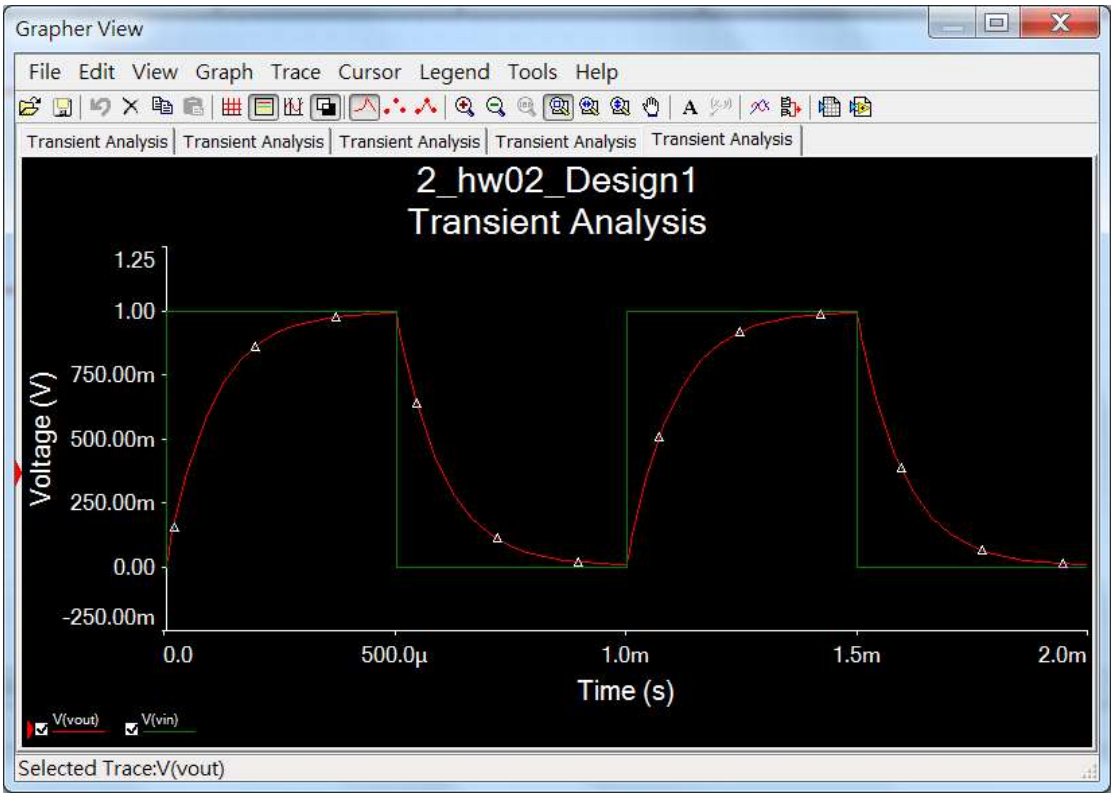


圖 2-7B 作業 2-2 Vout 波形