

108061112

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1. (a)

$$1V = R_1 \times 0.2mA + 26mV \ln \frac{0.2mA}{I_s} \quad (I)$$

$$2V = R_1 \times 0.5mA + 26mV \ln \frac{0.5mA}{I_s} \quad (II)$$

(II) - (I) gives

$$1V = R_1 \times 0.3mA + 26mV \ln \frac{0.5mA}{0.2mA}$$

$$R_1 = 3253.92147 \Omega \quad (III)$$

(III) and (I) gives

$$1V = 3253.92147 \Omega \times 0.2mA + 26mV \ln \frac{0.2mA}{I_s}$$

$$I_s = 2.936694 \cdot 10^{-10} A$$

1. (b)

$$26 \text{ mV} \ln \frac{0.5 \text{ mA}}{2.936694 \cdot 10^{-10} \text{ A}} = 0.373039265 \text{ V}$$

$$\frac{2.05 \text{ V} - 0.373039265 \text{ V}}{3253.92147 \Omega} = 5.153660746 \cdot 10^{-4} \text{ A}$$

$$26 \text{ mV} \ln \frac{5.153660746 \cdot 10^{-4} \text{ A}}{2.936694 \cdot 10^{-10} \text{ A}} = 0.3738262688 \text{ V}$$

$$\frac{2.05 \text{ V} - 0.3738262688 \text{ V}}{3253.92147 \Omega} = 5.151242114 \cdot 10^{-4} \text{ A}$$

$$26 \text{ mV} \ln \frac{5.151242114 \cdot 10^{-4} \text{ A}}{2.936694 \cdot 10^{-10} \text{ A}} = 0.373814064 \text{ V}$$

$$\frac{2.05 \text{ V} - 0.373814064 \text{ V}}{3253.92147 \Omega} = 5.151279622 \cdot 10^{-4} \text{ A}$$

$$26 \text{ mV} \ln \frac{5.151279622 \cdot 10^{-4} \text{ A}}{2.936694 \cdot 10^{-10} \text{ A}} = 0.3738142533 \text{ V}$$

$$\frac{2.05 \text{ V} - 0.3738142533 \text{ V}}{3253.92147 \Omega} = 5.15127904 \cdot 10^{-4} \text{ A}$$

$$\approx 5.15128 \cdot 10^{-4} \text{ A}$$

1.(c)

$$\frac{26 \text{ mV}}{0.5 \text{ mA}} = 52 \Omega$$

$$\frac{52 \Omega}{3253.92147 \Omega + 52 \Omega} (2.05 \text{ V} - 2 \text{ V}) = 3.86468 \times 10^{-4} \text{ V}$$

$$\frac{3.86468 \times 10^{-4} \text{ V} \times 0.5 \text{ mA}}{26 \text{ mV}} = 1.51243762 \times 10^{-5} \text{ A}$$

$$0.5 \text{ mA} + 1.51243762 \times 10^{-5} \text{ A}$$

$$= 5.151243762 \times 10^{-4} \text{ A}$$

以 large signal model 求得 0.515128 mA ，
以 small signal model 求得 0.515124 mA 。
兩者結果差異不大。
small signal model 計算較簡便，
且仍相當精確。

LTspice XVII - [Draft1.asc]

File Edit Hierarchy View Simulate Tools Window Help

Draft1.asc Draft2 Draft2.asc Draft3.asc

V1
2.05

R1
3253.92147

D
D

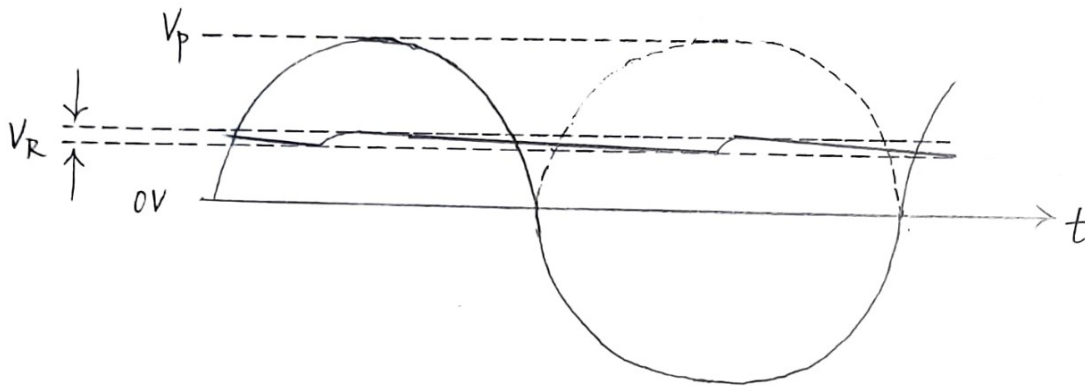
.op .model D D (Is=2.936694e-10)

```

--- Operating Point ---
V(a001):      2.05      voltage
V(a):         0.633606  voltage
I(D):         0.000435289 device_current
I(R1):        0.000435288 device_current
I(V1):       -0.000435288 device_current
  
```

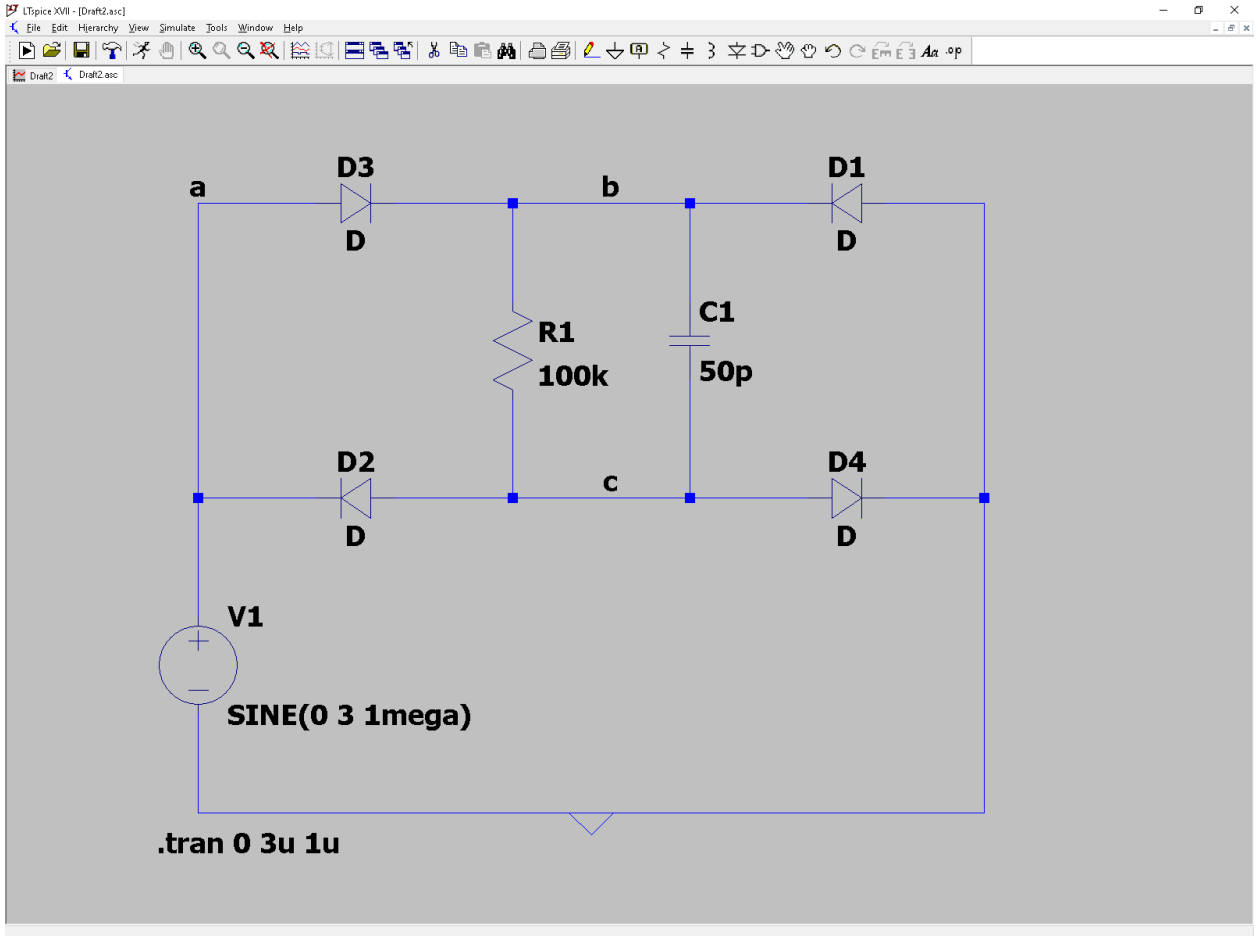
Ready

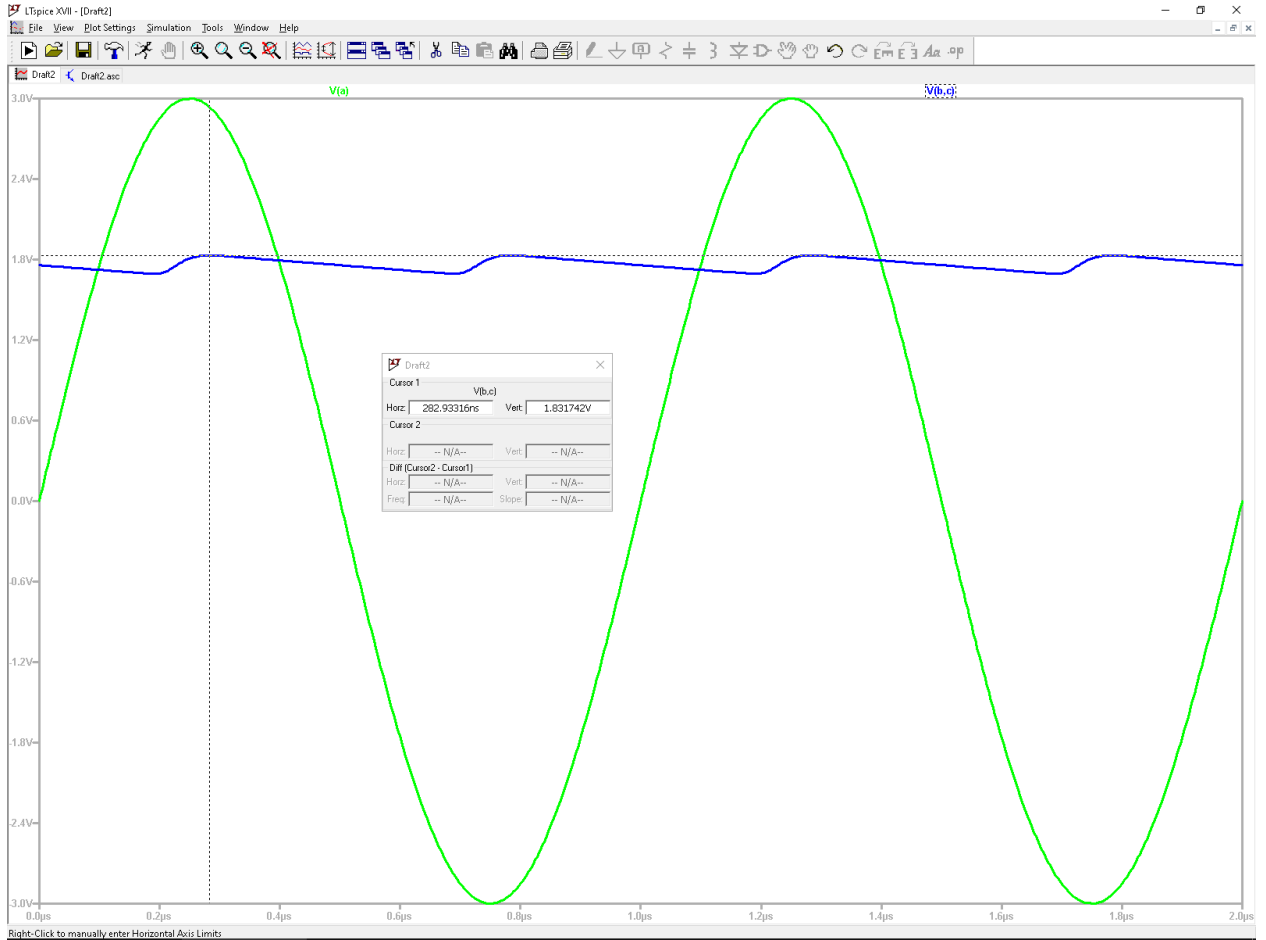
2.(a)(b)

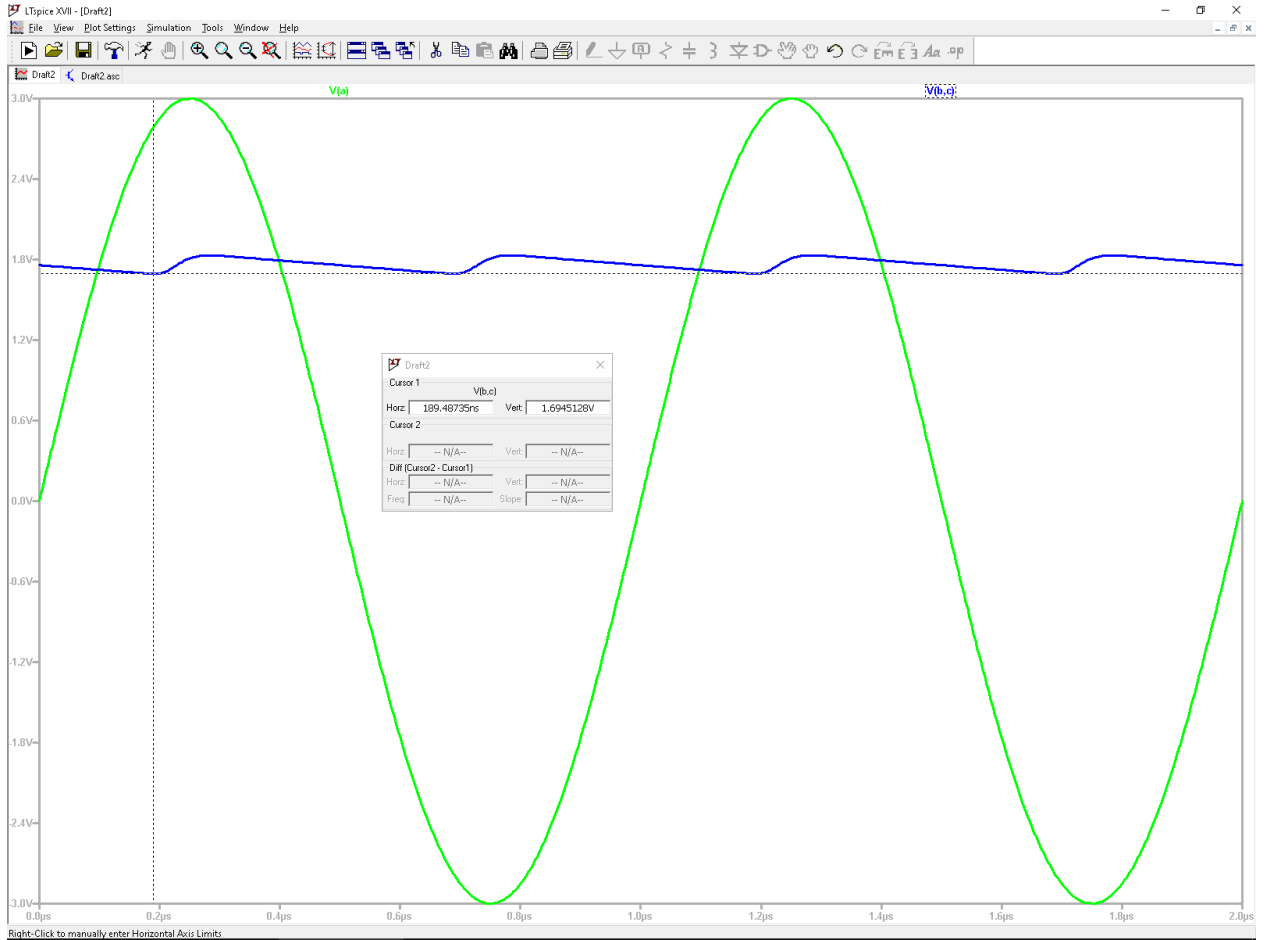


$$V_p = 3V$$

$$V_R = \frac{1}{2} \cdot \frac{3V - 2 \times 0.8V}{100k\Omega \times 50pF \times 1MHz} = 1.4 \times 10^{-1} V$$







用課本公式 (3.94) 求得 ripple 約 0.14V ，
跟 spice 模擬結果相符。