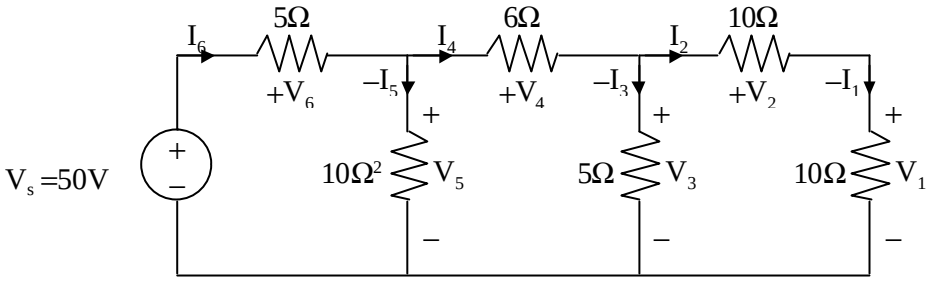
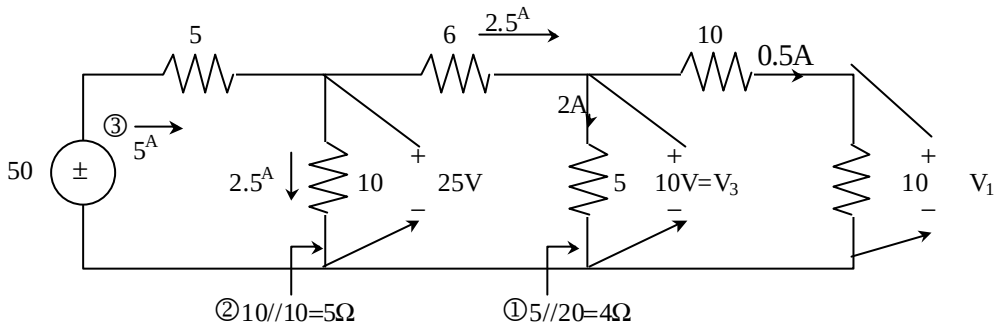
《電子學與電路學》

一、如圖一所示，試求出V_1、V_3及由電源V_S所提供之功率P_S。（15分）



圖一

【擬答】

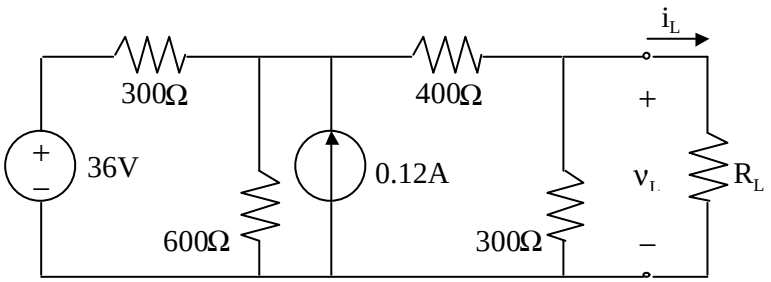


V_1之值為$V_1 = 0.5 \times 10 = 5$

$V_3 = 10V$

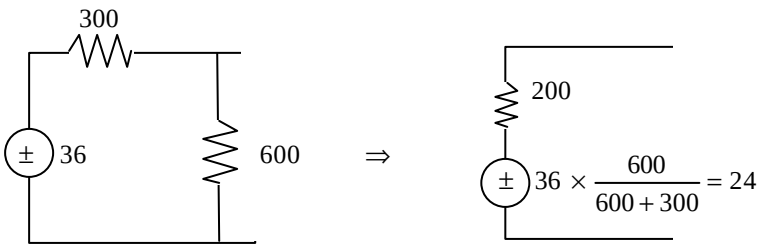
V_S供給之功率為$50 \times 5 = 250$瓦

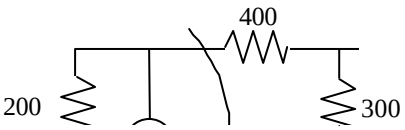
二、如圖二所示電路，為得到最大功率傳輸所需的R_L值為何？此時相對應的最大功率P_{Lmax}為何？（15分）

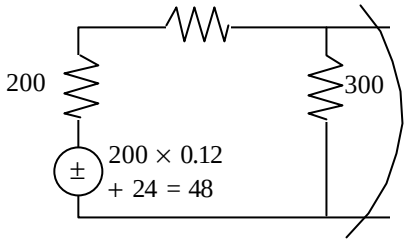


圖二

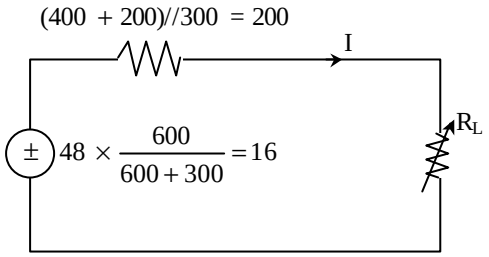
【擬答】







⇒



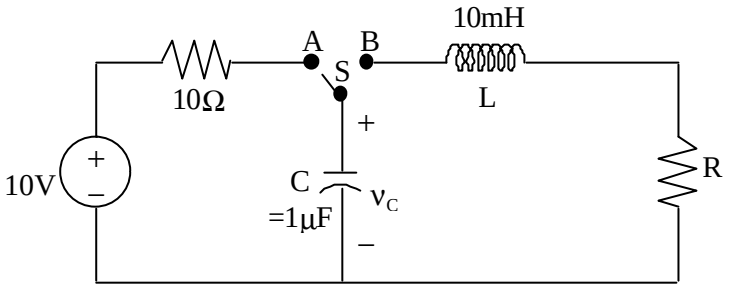
當$R_L = 200\Omega$有P_{max}

$$I = \frac{16}{200+200} = 0.04$$

$$P_{max} = (0.04)^2 \times 200 = 0.32 \text{瓦}$$

三、圖三所示開關S於A點放置良久並達穩態，於$t = 0$時將S移到B點位置。於下列兩情況下，試分別求出並畫出$t \geq 0$時之$v_C(t)$：

(一)$R = 20\Omega$；(二)$R = 200\Omega$。（20分）



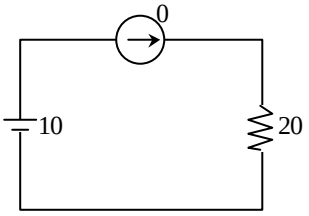
圖三

【擬答】

(一) $R = 20\Omega$

$-\infty < t < 0 \quad V_c(0) = 10$

$t = 0^+$



$$i_c(0^+) = 0 = c\frac{d}{dt}V_c(0^+), V_c'(0^+) = 0$$

$0 < t$

Natural

$$Z = R + SL + \frac{1}{SC} = 0$$

$$S^2 + \frac{R}{L}S + \frac{1}{LC} = 0$$

$$S^2 + 2000S + 10^8 = 0$$

$$S = \frac{1}{2}[-2000 \pm \sqrt{(2000)^2 - 4\times 10^8}] = -1000 \pm j9950$$

$$V_c(t) = Ae^{-1000t}\cos 9950t + Be^{-1000t}\sin 9950t$$

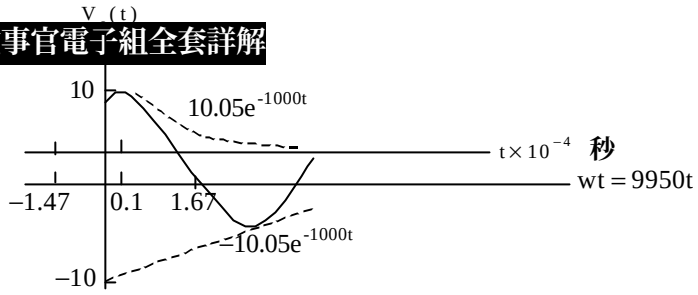
$$V_c(0) = 10 = A$$

$$V_c'(0^+) = 0 = -1000A + 9950B, \quad B = 1.005$$

$$\Rightarrow V_c(t) = 10e^{-1000t}\cos 9950t + 1.005e^{-1000t}\sin 9950t$$

又$1.005 + j10 = 10.05\underline{84.26°} = 10.05\underline{1.47}$

$\Rightarrow V_c(t)=10.05e^{-1000t}\sin(9950t+1.47)$



(二) $R=200\Omega$

$-\infty<t<0 \quad V_c(0)=10$

$t=0^+ \quad i_c(0^+)=c\frac{d}{dt}V_c(0^+), \quad V_c'(0^+)=0$

Natural $S^2+\frac{R}{L}S+\frac{1}{LC}=0$

$S^2+2000S+10^8=0$

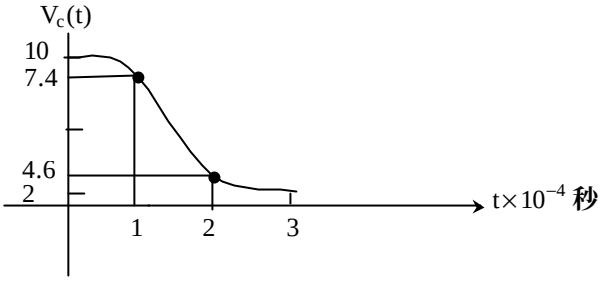
$S=\frac{1}{2}[-2000\pm\sqrt{(20000)^2-4\times10^8}=-10000$

$\Rightarrow V_c(t)=A_1e^{-10000t}+A_2te^{-10000t}$

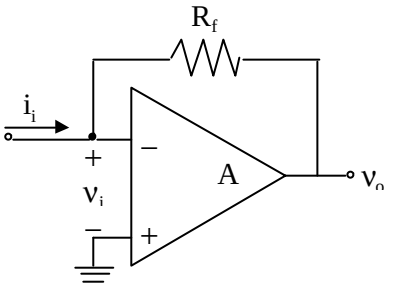
$V_c(0)=10=A_1$

$V_c'(0^+)=0=-10000A_1+A_2 \quad A_2=100000$

$V_c(t)=10e^{-10000t}+10^5te^{-10000t}$



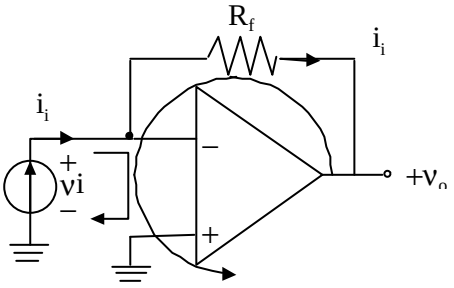
四、圖四所示電路，請於下列兩種情況下分別導出互阻$R_m\equiv\nu_o/i_i$及輸入電阻$R_i\equiv\nu_i/i_i$的表示式：(一)A是無限大；(二)A是有限值。（16分）



圖四

【擬答】

(一) A=∞

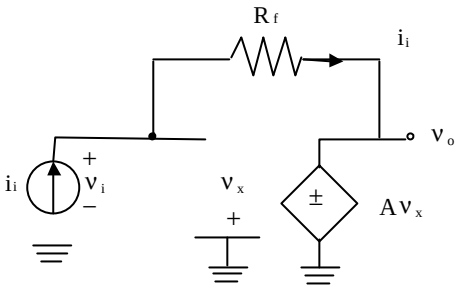


$\nu_i=i_i\times o$

$R_i=\frac{\nu_i}{i_i}=o^{\Omega}$

$\nu_0=-i_iR_f\Rightarrow\frac{\nu_0}{i_i}=R_m=-R_f\frac{\bar{\nu}}{A}$

(二) A為有限值



$$\begin{cases} v_i + v_x = 0 \\ v_i - Av_x = i_i R_f \end{cases} \rightarrow \begin{cases} v_i = -v_x + oi_i \\ v_i = Av_x + i_i R_f \end{cases}$$

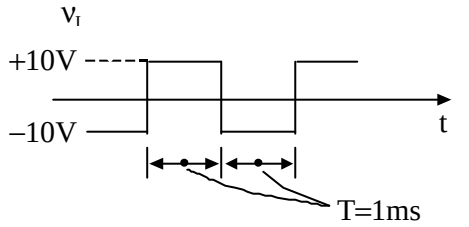
$$i_i = \frac{v_i(-1-A)}{-R_f + 0} = v_i \frac{1+A}{R_f}$$

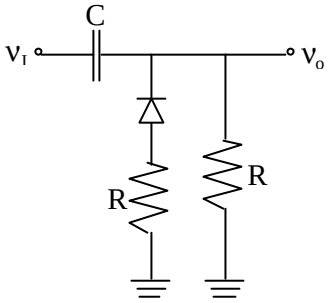
$$R_i = \frac{v_i}{i_i} = \frac{R_f}{1+A}$$

$$v_0 = -i_i R_f + v_i = -i_i R_f + \frac{R_f}{1+A} i_i = i_i \frac{-AR_f}{1+A}$$

$$R_m = \frac{v_0}{i_i} = \frac{-AR_f}{1+A}$$

五、圖五所示電路中所使用之二極體為理想的，試對所示之輸入電壓繪出輸出電壓之波形。假設$CR >> T$**。（14分）**



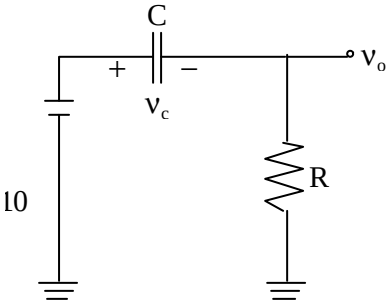


圖五

【擬答】

依題意及配分，應只求一個週期即可！

0<t<T

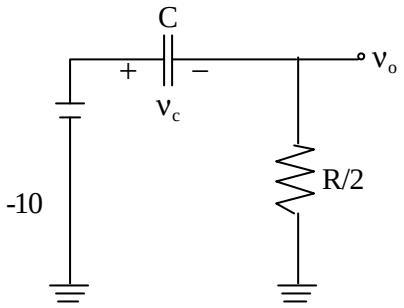


$$v_c(t) = 10\left[1 - e^{-\frac{t}{RC}}\right] = 10\frac{t}{RC}$$

$$v_0(t) = 10 - v_c = 10 - 10\frac{t}{RC}$$

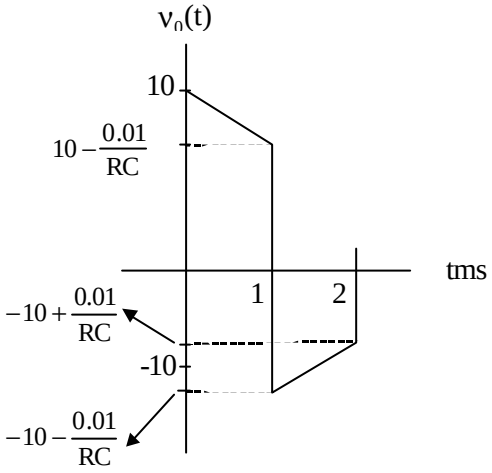
$$v_c(T) = 10\frac{T}{RC} = \frac{0.01}{RC}$$

T<t<2T



$$\nu_c(t) = -10\left[1 - e^{-\frac{2(t-T)}{RC}}\right] + \frac{0.01}{RC}e^{\frac{2(t-T)}{RC}} = -\frac{20t}{RC} + \frac{0.03}{RC}$$

$$\nu_0(t) = -10 - \nu_c = -10 + \frac{20t}{RC} - \frac{0.03}{RC}$$

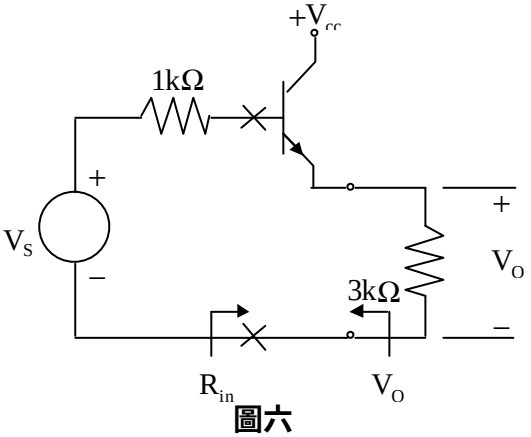


六、圖六共集極電路的電晶體低頻小訊號參數 $g_m = 40\text{mA/V}$、$\beta_o = 150$、$r_o \to \infty$ **且** $r_b \approx 0$**。**

(一)試畫出此放大級的小訊號等效電路。（5分）

(二)試決定 R_{in} **和** R_o**。（10分）**

(三)試求出轉移函數 V_o / V_s**。（5分）**

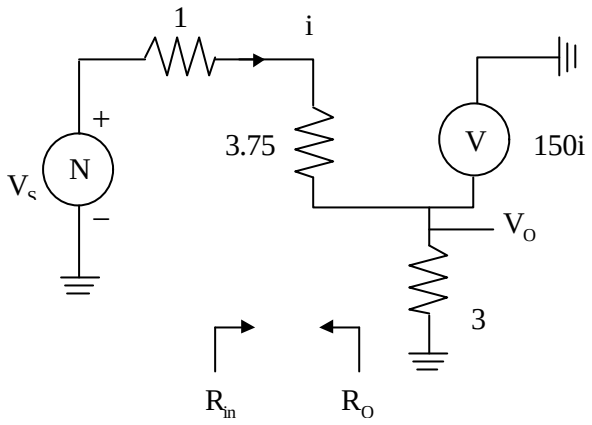


圖六

【擬答】

(一) (V; kΩ, mA, mA/V)

$\beta_0 = g_m r_\pi$，$r_\pi = \frac{\beta_0}{g_m} = \frac{150}{40} = 3.75$



(二) $R_{in}=\frac{v}{i}=\frac{3.75i+3\times151i}{i}=3.75+3\times151=456.75k\Omega$

$R_0=\frac{v}{151i}=\frac{i\times(3.75+1)}{151i}=\frac{4.75}{151}=0.03146\,k\Omega=31.46\Omega$

(三)

$$\frac{v_0}{v_s}=\frac{v_0}{i}\times\frac{i}{v_s}=\frac{151i\times3}{i}\times\frac{i}{i(1+R_{in})}=3\times151\times\frac{1}{1+456.75}=0.989$$

試題評析	今年題目較往年難，實超出一般電子學與電路學之概論範圍，正常情形下第一、二和六題應無問題，或者再加第四題，亦即可能高標準之分數應為60分，至於第五題為RC充放電之一次電路與第三題之RLC2次電路，相互輝映，不過第五題之RC>>T之條件是用泰勒級數㊣處理的！實較繁瑣！一般來講，正常的分數應落在30分左右！至於班上的同學，應有75分的實力！