生物產業機電工程學系電工學第二次考試解答

學號：_____ 姓名：_____

Problem 1 40%

a.圖 1a 電路的電壓源 v(t) = 169.706 sin (1000t) 、電流 i(t) = 16.639×10^{-3} cos (1000t－11.31º)。請問電路上兩個未知元件分別為何？其電阻值？或電感值？或電容值？請把元件符號畫上去，並把電阻值或電感值或電容值標上去【注意單位，沒有標示單位不予計分】6%

b.圖 1b 電路的電壓源 v(t) = 84.853 sin (1000t+15.26º) 、電流 i(t) = 37.22 sin (1000t)。請問電路上兩個未知元件分別為何？其電阻值？或電感值？或電容值？請把元件符號畫上去，並把電阻值或電感值或電容值標上去【注意單位，沒有標示單位不予計分】6%

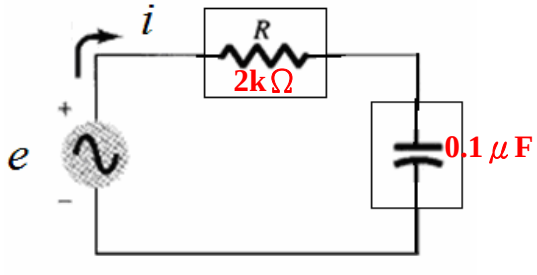


圖 1a

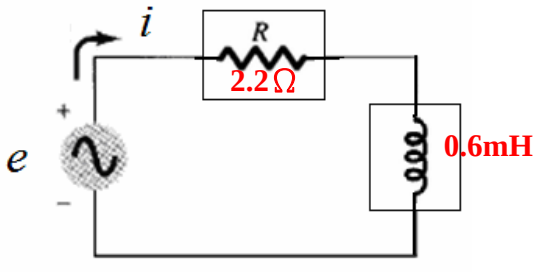
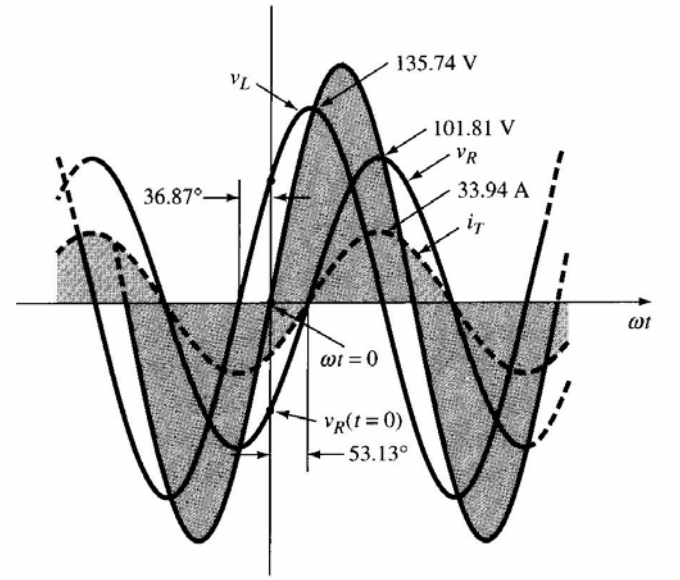


圖 1b

c. Write the sinusoidal expression for i_T、v_L、v_R. 6%



i_T = 33.94 A sin(ωt-53.13°)

v_L =135.74 V sin(ωt+36.87°)

v_R = 101.81Vsin(ωt-53.13°)

d. Write the sinusoidal expression for each quantity using the information provided 4%

I_{eff} = 36 mA, f = 1 kHz, phase angle = 60°

i (t) = 50.9×10^{-3}Asin(6283.2t+60°)

V_{eff} = 8V, f =60 Hz, phase angle = -10°

v(t) = 11.31Vsin(377t-10°)

e. Find the sinusoidal expression for the voltage drop across a 20-mH coil if the current i_L is 4 cos(500t -30°) 4%

v(t) = 40Vsin (500t+150°)

f. Determine the sinusoidal expression for the current i_c of a 10-μF capacitor if the vo1tage across the capacitor is $V_c = 20\times10^{-3}\sin(2000t + 30°)$ 4%

i(t) = 0.4 mA sin(2000t+120°)

g. For the following pairs determine the real power delivered to the load, find the power factor.

$v(t) = 100\,V\sin(10^6 t - 10°)$ $i(t) = 0.2A\cos(10^6 t - 40°)$ 4%

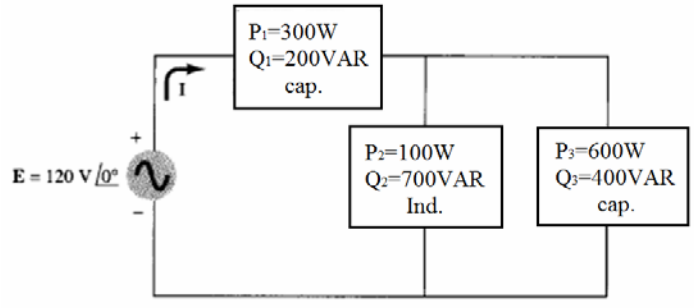
Real power = 5W Power factor = 0.5 （☐lagging ■leading）

h. For the following pairs determine whether the element is a resistor, inductor, or capacitor, and determine the resistance, inductance, or capacitance.

$v(t) = 16\,V\sin(200t + 80°)$ $i(t) = 0.04\,A\sin(200t - 10°)$

Inductor, L = 2H

Problem 2 12%



f= 60 Hz

a. Total real power = 1000W

b. Net reactive power = 100VAR

c. Apparent power = 1005VA

d. The current i(t) = 11.844sin(377t-5.718°)

e. The power factor = 0.995

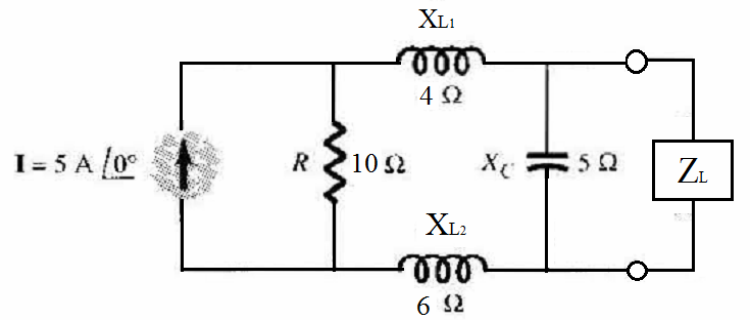
■lagging ☐leading

Problem 3 24%

a.找出負載（Load）Z_L 左側電路的 Thévenin equivalence. 12%

b.要讓負載（Load）Z_L 得到最大功率（Maximum power），負載 Z_L 是由哪些元件組合而成？元件的電阻值（Resistance）或電感值（Inductance）或電容值（Capacitance）8%

c.最大功率？ 4%



$Z_1 = 10\Omega\angle 0°$ $Z_2 = 4\Omega\angle 90°$ $Z_3 = 6\Omega\angle 90°$ $Z_4 = 5\Omega\angle -90°$

透過 source conversion 將 I 與 Z_1 的並聯轉換成 V 與 Z_1 的串聯

$$Z_{TH} = (Z_1 + Z_2 + Z_3) // Z_4 = 6.325\Omega\angle -71.565° = 2\Omega - j6\Omega$$

$$E_{TH} = V \cdot \frac{Z_4}{Z_1 + Z_2 + Z_3 + Z_4} = 50\angle 0° \cdot \frac{5\Omega\angle -90°}{10\Omega + j5\Omega} = 22.361V\angle -116.565°$$ 6+6 %

其中，$R_{TH} = 2\Omega$

For max. power transfer

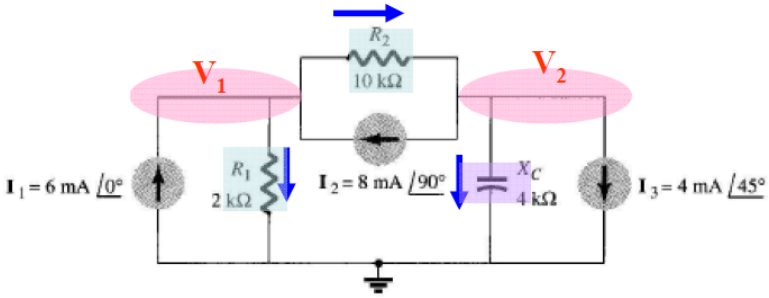
$$Z_L = 2\Omega + j6\Omega$$ 4+4%

電阻與電感串聯，電阻的電阻值 2Ω、電感的電感值 6mH。

$$P_{mzx} = \frac{E^2_{TH}}{4R_{TH}} = \frac{22.361^2}{8} = 62.502W$$ 2+2%

Problem 4 24%

求流經 R_2、X_C 的電流（Phasor notation），並指出電流流向（建議利用 Nodal analysis）。【記得參考課堂上的說明，有秩序的在電路上標註符號，寫出方程式，代入數字，….計算。】



$Z_1 = 2\text{k}\Omega\angle 0° \qquad Z_2 = 10\text{k}\Omega\angle 0° \qquad Z_3 = 4\text{k}\Omega\angle -90°$

NODE 1 $I_1 + I_2 - \frac{V_1}{Z_1} - \frac{V_1 - V_2}{Z_2} = 0$ **3%** **NODE 2** $\frac{V_1 - V_2}{Z_2} - I_2 - I_3 - \frac{V_2}{Z_3} = 0$ 3%

$$V_1\left(\frac{1}{Z_1}+\frac{1}{Z_2}\right) - V_2\left(\frac{1}{Z_2}\right) = I_1 + I_2$$

$$V_1\left(\frac{1}{Z_2}\right) - V_2\left(\frac{1}{Z_2}+\frac{1}{Z_3}\right) = I_2 + I_3$$

$$V_1 = \frac{\begin{vmatrix} I_1+I_2 & -\frac{1}{Z_2} \\ I_2+I_3 & -\left(\frac{1}{Z_1}+\frac{1}{Z_2}\right) \end{vmatrix}}{\begin{vmatrix} \frac{1}{Z_1}+\frac{1}{Z_2} & -\frac{1}{Z_2} \\ \frac{1}{Z_2} & -\left(\frac{1}{Z_1}+\frac{1}{Z_2}\right) \end{vmatrix}} \quad 5\% \qquad V_2 = \frac{\begin{vmatrix} \frac{1}{Z_1}+\frac{1}{Z_2} & I_1+I_2 \\ \frac{1}{Z_2} & I_2+I_3 \end{vmatrix}}{\begin{vmatrix} \frac{1}{Z_1}+\frac{1}{Z_2} & -\frac{1}{Z_2} \\ \frac{1}{Z_2} & -\left(\frac{1}{Z_1}+\frac{1}{Z_2}\right) \end{vmatrix}} \quad 5\%$$

$= 13.133\text{V}\angle 72.58° \qquad = 36.72\text{V}\angle -172.47°$

$$I_{XC} = \frac{V_2}{Z_3} = \frac{36.72\text{V}\angle -172.47°}{4\text{k}\Omega\angle -90°} = 9.18\text{mA}\angle -82.47°$$ 3+1%

$$i_{xc}(t) = 12.983\text{mA}\sin(\omega t - 82.47°)$$

$$I_{R2} = \frac{V_1 - V_2}{Z_2} = \frac{13.133\text{V}\angle 72.58° - 36.72\text{V}\angle -172.47°}{10\text{k}\Omega\angle 0°} = \frac{43.903\text{V}\angle 23.267°}{10\text{k}\Omega\angle 0°}$$

$= 4.3903\text{mA}\angle 23.267°$ 3+1%

$$i_{R2}(t) = 6.209\text{mA}\sin(\omega t + 23.267°)$$