國立宜蘭大學一百零三學年度第 二 學期電磁學作業						分數
第幾回	命 題 教 師	作業範圍	班級	學 號	姓　　名	
3	邱建文	Ch8. 1-Ch. 8. 4	電子二乙			

本次作業完成方式:□獨立完成 □與他人討論完成 □參考別人完成,參考________同學(請誠實勾選一項)

1. A $V_s = 5\angle 0°$ (V) generator operating at 500 (MHz) with an internal resistance 50 (Ω) is connected to a 2-meter-long lossless 50 (Ω) air line that is terminated in a 30 +*j*30 (Ω) load. Find (a) *V(z)* at a location z from the generator, (b) V_i at the input terminals and V_L at the load, (c) the SWR on the line, (d) the average power delivered to the load.

$V_g = 5\angle 0°$ $Z_g = 50\,\Omega$ $R_0 = 50\,\Omega$ $Z_L = 30 + j30 = 30\sqrt{2}\angle 45°$ $l = 2m$

$f = 500MHz = 5\times 10^8 Hz$ $\beta l = \frac{\omega}{c} l = \frac{2\pi \times 5\times 10^8}{3\times 10^8}\times 2 = \frac{20\pi}{3}$ $\beta = \frac{10}{3}\pi$ $\angle 0.573\pi$

$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{30 + j30 - 50}{30 + j30 + 50} = \frac{-20 + j30}{80 + j30}\times\frac{80 - j30}{80 - j30} = \frac{-700 + j3000}{7300} = -0.096 + j0.411 = 0.422\angle 103.147°$

(a) $V(z' = l) = V_i = \frac{I_L}{2}(Z_L + Z_0)e^{\gamma(l-z)}\left[1 + \Gamma e^{-2\gamma(l-z)}\right]$, $I(z' = l) = I_i = \frac{I_L}{2Z_0}(Z_L + Z_0)e^{\gamma(l-z)}\left[1 - \Gamma e^{-2\gamma(l-z)}\right]$

$V_g = V_i + I_i Z_0 = I_L(Z_L + Z_0)e^{\gamma(l-z)}$ $V(z) = \frac{V_g}{2}e^{-j\beta z}\left[1 + \Gamma e^{-j2\beta(l-z)}\right]$

$V(z) = \frac{5}{2}e^{-j\frac{10}{3}\pi z}\left[1 + 0.422 e^{j(0.573 - \frac{40}{3})\pi} e^{j\frac{20}{3}\pi z}\right] = 2.5\left[e^{-j\frac{4}{3}\pi z} + 0.422 e^{j(\frac{4}{3}z - 0.76)\pi}\right]$ (V)

2. The open-circuit and short-circuit impedances at the input terminals of a 2-meter-long lossless transmission line, which is less than a quarter wavelength, are $-j50$ (Ω) and $j200$ (Ω), respectively. (a) Find Z_o and β of the line. (b) Without changing the frequency, find Z_{in} of a short-circuited line with $l = 4$ m.

第一題延伸

(b) $V_i = V(0) = 2.5\left[1 + 0.422 e^{-j(\frac{40}{3} - 0.573)\pi}\right] = 2.5\left[1 + 0.422 e^{-j0.76\pi}\right] = 2.5(0.692 - j0.289)$
$= 18.748\angle -22.75°$ (V)

$V_L = V(2) = 2.5\left[e^{-j0.67\pi} + 0.422 e^{j0.097\pi}\right]$

$= 2.5(-0.106 - j0.984) = 24.81\angle 83.84°$ (V)

(c) $S = \frac{1 + |\Gamma|}{1 - |\Gamma|} = \frac{1 + 0.422}{1 - 0.422} = 2.4602$

(d) $P_{av} = \frac{1}{2}\left|\frac{V_L}{Z_L}\right|^2 R_L = \frac{1}{2}\left(\frac{24.81}{42.4264}\right)^2 \times 30 = 5.129$ (W)

第二題解答在後面(另一頁)

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3. For the transmission line shown in below, *f=600MHz*, $v = 2\times 10^8$ *m/s*, *l* = 53 *cm*, $Z_o = 75\Omega$, $V_g = 20\angle 40°$, $Z_g = 30\Omega$, $Z_L = 100 - j300\Omega$ Determine (a) the line length as a fraction of a wavelength, (b) the voltage reflection coefficient at the input to the line and at the load, (c) the input impedance to the line, (d) the time-domain voltages at the input to the line and at the load, (e) the average power delivered to the load, and the VSWR.

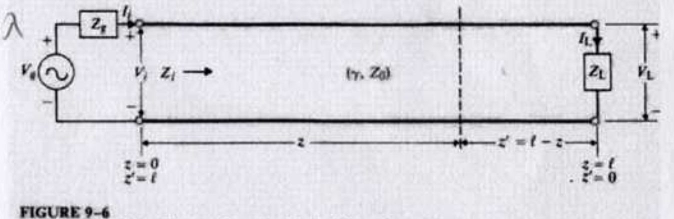

FIGURE 9-6
Finite transmission line terminated with load impedance Z_L.

(a) $\lambda = \frac{v}{f} = \frac{2\times 10^8}{6\times 10^8} = \frac{1}{3}m$, $l = 0.53m$ $\beta l = \frac{2\pi}{\lambda}\times 1.59\lambda$

$\therefore \frac{l}{\lambda} = \frac{0.53}{\frac{1}{3}} = 1.59 \Rightarrow k = \frac{lf}{v} = \frac{l}{\lambda} = 1.59$

(b) $\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{25 - j300}{175 - j300}\times\frac{175 + j300}{175 + j300} = \frac{94375 - j45000}{120625}$

$= 0.78 - j0.373 = 0.86\angle -25.56°$

$\Gamma_{in} = \Gamma(0)e^{-2j\beta l}$ $(\beta l = \frac{2\pi}{\lambda}\times 1.59\lambda = 3.18\pi)$ $= (0.86\angle -25.56°)e^{-j6.36\pi} = 0.86\angle -90.36°$

(c) $Z_{in} = Z_0\frac{Z_L + jZ_0\tan\beta l}{Z_0 + jZ_L\tan\beta l} = 75\times\frac{(100 - j300) + j75\tan 212.4°}{75 + j(100 - j300)\tan 212.4°} = 75\times\frac{100 - j252.4}{265.786 + j63.467} = 75\times\frac{271.488\angle -68.3867°}{272.868\angle 13.4486°}$

$= \frac{75}{74457.1544}(10520.7912 - j73329.6294) = 10.597 - j73.864$ $= 74.62\angle -81.8353°$

(d) $V(z = -l) = V_g\times\frac{Z_{in}}{Z_g + Z_{in}} \Rightarrow Z_g + Z_{in} = 30 + 10.597 - j73.864 = 40.597 - j73.864 = 84.283\angle -61.206°$

$V = 20\angle 40°\times\frac{74.62\angle -81.8353°}{84.283\angle -61.206°} = 17.7066\angle 19.3707°$ (e) $VSWR = \frac{1 + |\Gamma_L|}{1 - |\Gamma_L|} = \frac{1 + 0.86}{1 - 0.86} = 13.28$