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	
1	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. 在 10(MHz)時無失真同軸傳輸線的衰減常數為 0.1(dB/km)。決定它在下列情況的值
   (a). 在 50(MHz)時
   (b). 在 10(MHz)時若絕緣材料的介電常數加倍

Ex2 $20\log e^{\alpha\,Np/m} = dB/m$ 衰減常數

(a) $\alpha = R\sqrt{\frac{C}{L}} = \sqrt{\frac{\pi f\mu\sigma}{\sigma_c}}\left(\frac{1}{a}+\frac{1}{b}\right)\cdot\sqrt{\frac{2\pi\varepsilon}{\ln(\frac{b}{a})}\times\frac{2\pi}{\mu\ln(\frac{b}{a})}}$ 裡面只有 f 從 10MHz 變成 50MHz ∴ α會變 $\sqrt{5}$ 倍

$20\log e^{\alpha} = 0.1\,(dB/km)$ $\log e^{\alpha} = 0.005$ $e^{\alpha} = 10^{0.005} = 1.01158$ $\alpha = \ln 1.01158 = 0.011513\ (Np/km)$

$\sqrt{5}\times 0.011513 = 0.025744\ (Np/km) = 20\log e^{0.025744}\ (dB/km) = 0.22361\ (dB/km)$ (直接乘 $\times 0.1 dB/km$ 相同)

(b) 介電常數 ε 加倍 ⇒ α 增加 $\sqrt{2}$ 倍 ∴ $\sqrt{2}\times 0.1 = 0.141\ (dB/km)$

$20\log e^{\alpha} = 0.141\ (dB/km)$ $\log e^{\alpha} = \frac{0.141}{20} = 7.05\times10^{-3}$ $\Rightarrow e^{\alpha} = 10^{7.05\times10^{-3}} = 1.016$ $\alpha = \ln 1.016 = 0.016\ (Np/km)$

2. 下列性質在在 100(MHz)時有一損耗傳輸線上所測到的 $Z_0=50+j0$, α=0.01(dB/m), β=0.8π(rad/m) ,決定此線的 R、L、G 與 C

$Z_0 = \frac{R+j\omega L}{Y} = \frac{Y}{G+j\omega C}$ $\alpha = 0.01\,(dB/m) = \ln 10^{\frac{0.01}{20}}\,(Np/m) = 0.0011513\ (Np/m)$

$\omega = 2\pi f = 2\pi\times 100M$

$Z_0 = \frac{R+j\omega L}{0.0011513+j0.8\pi} = 50 \Rightarrow R+j\omega L = 0.057565 + j40\pi$

① $R = 0.057565\,(\Omega/m)$ $\omega L = 2\pi\times10^8 L = 40\pi$ ② $L = 2\times10^{-7} = 0.2\,(\mu H/m)$

$Z_0 = \frac{Y}{G+j\omega C} = \frac{0.0011513+j0.8\pi}{G+j\omega C} = 50 \Rightarrow G+j\omega C = 0.00002302 + j0.016\pi$

③ $G = 23(\mu S/m)$ $\omega C = 2\pi\times10^8 C = 0.016\pi \Rightarrow C = 0.008\times10^{-8} = 0.08(nF/m)$

3. 若無失真同軸傳輸線內導體半徑為 0.6mm，外導體內徑為 3.91mm，在其間的介質的介電常數為 2.25，請計算無失真同軸傳輸線在 1(MHz)的衰減常數與相位常數與特性阻抗。

$a = 0.6mm$ $b = 3.91mm$ $\varepsilon_r = 2.25$ $\varepsilon = \varepsilon_0\varepsilon_r = \frac{10^{-9}}{36\pi}\times 2.25$

$\alpha = R\sqrt{\frac{C}{L}}$ $L = \frac{\mu}{2\pi}\ln\frac{b}{a} = \frac{4\pi\times10^{-7}}{2\pi}\times\ln\frac{3.91}{0.6} = 2\times10^{-7}\times1.874 = 3.748\times10^{-7}$

$\beta = \omega\sqrt{LC}$ $C = \frac{2\pi\varepsilon}{\ln\frac{b}{a}} = 2\pi\times\frac{10^{-9}}{36\pi}\times2.25 / \ln\frac{3.91}{0.6} = 0.125\times10^{-9}/1.874 = 0.0667\times10^{-9}$

$Z_0 = R_0 + jX_0 = \sqrt{\frac{R+j\omega L}{\frac{RC}{L}+j\omega C}}$ $Z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{3.748\times10^{-7}}{0.0667\times10^{-9}}} = 74.96\,(\Omega)$

$= \frac{R+j\omega L}{\alpha+j\beta}\sqrt{\frac{L}{C}}$ $\beta = \omega\sqrt{LC} = 2\pi\times10^6\sqrt{3.748\times0.0667\times10^{-7}\times10^{-9}} = 2\pi\times10^6\times10^{-8}\times0.5 = 0.01\pi\ (rad/mm)$

$R_s = \sqrt{\frac{\pi f\mu_c}{\sigma_c}} = \sqrt{\frac{\pi\times10^6\times4\pi\times10^{-7}}{5.8\times10^7}}$ $\alpha = R\sqrt{\frac{C}{L}} = \frac{R_s}{2\pi}\left(\frac{1}{a}+\frac{1}{b}\right)\times\sqrt{\frac{c}{L}} = \frac{2.61\times10^{-4}}{2\pi}\left(\frac{1}{0.6}+\frac{1}{3.91}\right)\times10^3\times\sqrt{\frac{0.0667\times10^{-9}}{3.748\times10^{-7}}}$

$= 2.61\times10^{-4}\,(\Omega)$ $= 1.065\times10^{-3}\,(Np/m) = 20\log e^{1.065\times10^{-3}}\,(dB/m) = 9.253\times10^{-3}\,(dB/m)$