北京航空航天大學
BEIHANG UNIVERSITY
Add: 37 Xueyuan Rd. Haidan District
Beijing.China.100191
Fax: 86(10)82838058

18373038 钱恩远

3-18

~~解~~ 证明:

TEmn模式

$\vec{S} = \frac{1}{2}\vec{E}\times\vec{H}^* = \hat{i}_x S_x + \hat{i}_y S_y + \hat{i}_z S_z$

导通状态下 $\gamma = j\beta$.

$S_x = \frac{1}{2} E_y H_z^*$

$= -\frac{1}{2}\eta_{TE}\frac{j\beta}{k_c^2}(\frac{m\pi}{a})|H_{mn}|^2\sin(\frac{m\pi}{a}x)\cos(\frac{m\pi}{a}x)\cdot\cos^2(\frac{n\pi}{b}y)$

$S_y = \cancel{\frac{1}{2}E_z H_x^*} - \frac{1}{2}E_x H_z^*$

$= -\frac{1}{2}\eta_{TE}\frac{j\beta}{k_c^2}(\frac{n\pi}{b})|H_{mn}|^2\cos^2(\frac{m\pi}{a}x)\sin(\frac{n\pi}{b}y)\cos(\frac{n\pi}{b}y)$

$S_z = \frac{1}{2}E_x H_y^* - \frac{1}{2}E_y H_x^* = \frac{1}{2}\eta_{TE}|H_y|^2 + \frac{1}{2}\eta_{TE}|H_x|^2$

TM模式同理

表示只沿z方向传输有功功率.

3-19 TE10模式:

解: $P_{max} = P_{br} = \frac{ab}{480\pi}E_{br}^2\sqrt{1-(\frac{\lambda}{2a})^2}$

$= \frac{2.286\times1.016}{480\pi}\cdot(30k)^2\sqrt{1-(\frac{3\times10^8}{9.375\times10^9\cdot2.286\times10^{-2}})^2}$

$= 9.98\times10^5$ W.

3-21

解: ① $k_c = \sqrt{(\frac{\pi}{a})^2+(\frac{\pi}{b})^2}$.

$\lambda_c = \frac{2\pi}{k_c} = \frac{2}{\sqrt{\frac{1}{a^2}+\frac{1}{b^2}}} = 18.34$ mm.

$f_c = \frac{v}{\lambda_c} = 16.36$GHz

$\beta = \frac{2\pi}{\lambda_0}\sqrt{1-(\frac{\lambda_0}{\lambda_c})^2} = 0.241$ rad/mm.

$\lambda_g = \frac{2\pi}{\beta} = 26.1$ mm

$v_p = \frac{v}{G} = \frac{c}{\sqrt{1-(\frac{\lambda_0}{\lambda_c})^2}} = 5.21\times10^8$ m/s.

$\eta_{TE_{11}} = \frac{120\pi}{\sqrt{1-(\frac{\lambda_0}{\lambda_c})^2}} = 655\Omega$.

② $f = 10$GHz $< f_c$. 截止

$\gamma = \frac{2\pi}{\lambda_0}\sqrt{(\frac{\lambda_0}{\lambda_c})^2-1} = 2.71$

3-22

解: ① $f_0 = 7.5$GHz. $\lambda_0 = \frac{c}{f_0} = 0.04$ m.

~~$f > f_c = c$~~

$0.04m = \lambda_0 < \lambda_c = \frac{2\pi}{k_c} = \frac{2\pi}{\sqrt{(\frac{m\pi}{a})^2+(\frac{n\pi}{b})^2}}$

∴ H_{10}, 可导通.

主模 H_{10}: $G = \sqrt{1-(\frac{\lambda_0}{\lambda_c})^2} = 0.6$.

$\lambda_c = 2a = 5$ cm.

$\beta = \frac{2\pi}{\lambda_0}\sqrt{1-(\frac{\lambda_0}{\lambda_c})^2} = \cancel{1.83}$ 0.94 rad/cm

$\lambda_g = \frac{2\pi}{\beta} = \cancel{3.43}$ 6.68 cm

$v_p = \frac{c}{G} = \frac{c}{\sqrt{1-(\frac{\lambda_0}{\lambda_c})^2}} = \cancel{3.64}$ 5 $\times10^8$ m/s

$v_g = cG = c\sqrt{1-(\frac{\lambda_0}{\lambda_c})^2} = \cancel{2.47}$ 1.8 $\times10^8$ m/s

$\eta_{H_{10}} = \frac{120\pi}{\sqrt{1-(\frac{\lambda_0}{\lambda_c})^2}} = \cancel{282\ 465\Omega}$ 200π

② $\lambda_0 = \frac{c}{\sqrt{\varepsilon_r}\cdot f_0} = 2.83\,cm$.

$(\lambda_c)_{H_{10}} = 2a = 5\,cm$

$(\lambda_c)_{H_{01}} = 2b = 3\,cm$.

∴ 可导通 H_{10}、H_{01}

$G = \sqrt{1-(\frac{\lambda_0}{\lambda_c})^2} = \sqrt{1-(\frac{2.83}{5})^2} = 0.824$.

$\beta = \frac{2\pi}{\lambda_g} = 1.83\ rad/cm$.

$\lambda_g = \cancel{2\pi}\frac{\lambda_0}{\sqrt{1-(\frac{\lambda_0}{\lambda_c})^2}} = 3.43\,cm$

$v_p = \frac{c}{\sqrt{\varepsilon_r}\sqrt{1-(\frac{\lambda_0}{\lambda_c})^2}} = 2.57\times10^8\ m/s$.

$v_g = \frac{c}{\sqrt{\varepsilon_r}}\cdot\sqrt{1-(\frac{\lambda_0}{\lambda_c})^2} = 1.75\times10^8\ m/s$.

$\eta_{TE10} = \frac{120\pi}{\sqrt{\varepsilon_r}\sqrt{1-(\frac{\lambda_0}{\lambda_c})^2}} = 323\,\Omega$.

3-23

解: $f_c = \frac{4.8}{1.25} = 3.84\,GHz$.

$\lambda_c = \frac{c}{f_c} = 7.8\,cm. = 2a$ $\quad a = 3.9\,cm$, $b = 1.95\,cm$.

$G = \sqrt{1-(\frac{\lambda_0}{\lambda_c})^2} = \sqrt{1-(\frac{5}{7.8})^2} = 0.768$

$\lambda_g = \frac{\lambda_0}{G} = \cancel{10.2}\ 6.51\ cm$.

$\beta = \frac{2\pi}{\lambda_g} = \cancel{0.616}\ 0.965\ rad/cm$.

$v_p = \frac{c}{G} = 3.91\times10^8\,m/s$.

3-24.

解: ① $\cancel{\lambda_c=}$

$32\,mm = \lambda_0 < \lambda_c = \frac{2}{\sqrt{(\frac{m}{a})^2+(\frac{n}{b})^2}}$.

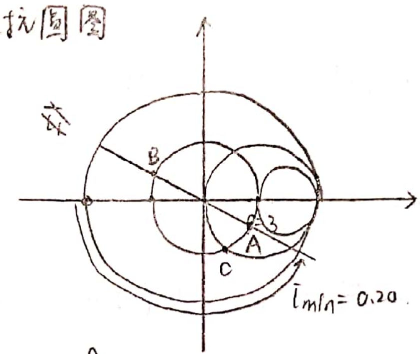
只能导通 H_{10} 模式

$\lambda_c = 2a = 4.572\,cm$.

$G = \sqrt{1-(\frac{\lambda_0}{\lambda_c})^2} = 0.714$.

$\lambda_g = \frac{\lambda_0}{G} \approx 4.48\,cm$.

② 阻抗圆图



$\bar{l}_{min} = \frac{9}{44.8} \approx 0.20$.

A 点旋转 180° 得 B 即为导纳值.

$\bar{l}_B = 0.05$

$\bar{Y}_L = \bar{Y}_B = 0.380 + j0.280$

等反射系数圆与可匹配圆交于 C.

$\bar{l}_c = 0.334$.

$\bar{Y}_c = 1 - j1.15$.

$\bar{Y} = \bar{Y}_c + \bar{Y} = 1$

$\bar{Y} = j1.15$.

$\cancel{\bar{d} = 0.334 - 0.25 = 0.084}$.

$\bar{d} = \bar{l}_c - \bar{l}_B = 0.284$.

$d = \bar{d}\cdot\lambda_g$