2024秋 非线性答案

第一章 1.1, 1.2, 1.3(3), 1.6

1.1 二极管、晶体管、场效应管

1.2 $G=\frac{I_D}{U_Q}=5+U_Q-0.5U_Q^2$ (mS)

$g=\left.\frac{di}{du}\right|_{u=U_Q}=5+2U_Q-1.5U_Q^2$ (mS)

$\because a_1u\to a_1U_1\cos\omega_1t$

$a_2u^2\to 2a_2U_QU_1\cos\omega_1t$

$a_3u^3\to 3a_3U_Q^2U_1\cos\omega_1t+\frac{3}{4}a_3U_1^3\cos\omega_1t$

$u=U_Q+U_1\cos\omega_1t$ 时 $G_{m1}=\frac{I_1}{U_1}=5+2U_Q-\frac{3}{2}U_Q^2-\frac{3}{8}U_1^2$ (mS)

代入具体值可得 1) $G=5.5$ mS $g=5.5$ mS $G_{m1}=5.40625$ mS

2) $G=2.375$ mS $g=-6.375$ mS $G_{m1}=-6.1875$ mS

1.3(3) 令 $\omega_1t=2\pi\times10^3t$ $\omega_2t=2\pi\times10^6t$

$i=5\cos\omega_1t+\cos\omega_2t+(\cos\omega_1t+\cos\omega_2t)^2-0.5(\cos\omega_1t+\cos\omega_2t)^3$

三倍角公式：$\cos3\alpha=4\cos^3\alpha-3\cos\alpha$

$=5\cos\omega_1t+\frac{5}{4}\cos\omega_2t+\frac{1}{2}\cos2\omega_1t+\frac{1}{2}\cos2\omega_2t+1+\cos(\omega_2+\omega_1)t+\cos(\omega_2-\omega_1)t$

积化和差：$\cos\alpha\cos\beta=\frac{1}{2}\cos(\alpha-\beta)+\frac{1}{2}\cos(\alpha+\beta)$

$-\frac{5}{8}\cos\omega_1t-\frac{1}{8}\cos3\omega_1t-\frac{3}{8}\cos(\omega_2-2\omega_1)t-\frac{5}{8}\cos\omega_2t-\frac{3}{8}\cos(\omega_2+2\omega_1)t-\frac{3}{8}\cos(2\omega_2-\omega_1)t-\frac{3}{8}\cos(2\omega_2+\omega_1)t-\frac{1}{8}\cos3\omega_1t$

$=1+\frac{3}{8}\cos\omega_1t+\frac{1}{2}\cos2\omega_1t-\frac{1}{8}\cos3\omega_1t-\frac{3}{8}\cos(\omega_2-2\omega_1)t+\cos(\omega_2-\omega_1)t+\frac{21}{8}\cos\omega_2t+\cos(\omega_2+\omega_1)t-\frac{3}{8}\cos(\omega_2+2\omega_1)t$

$-\frac{3}{8}\cos(2\omega_2-\omega_1)t+\frac{1}{2}\cos2\omega_2t-\frac{3}{8}\cos(2\omega_2+\omega_1)t-\frac{1}{8}\cos3\omega_2t$