$$|K^0(t)\rangle = \frac{1}{2}\,\frac{\sqrt{2(1+|\varepsilon|^2)}}{1+\varepsilon}\left(|K_S^0(t)\rangle + |K_L^0(t)\rangle\right) =$$

$$= \frac{\sqrt{2(1+|\varepsilon|^2)}}{2(1+\varepsilon)}\left(e^{-im_S t - \frac{\gamma_S t}{2}}|K_S^0\rangle + e^{-im_L t - \frac{\gamma_L t}{2}}|K_L^0\rangle\right) =$$

$$= \frac{\sqrt{2(1+|\varepsilon|^2)}}{2(1+\varepsilon)}\left(e^{-im_S t - \frac{\gamma_S t}{2}}\frac{1}{\sqrt{1+|\varepsilon|^2}}\left\{\frac{1+\varepsilon}{\sqrt{2}}|K^0\rangle - \frac{1-\varepsilon}{\sqrt{2}}|\bar{K}^0\rangle\right\}\right.$$

$$\left. + e^{-im_L t - \frac{\gamma_L t}{2}}\frac{1}{\sqrt{1+|\varepsilon|^2}}\left\{\frac{1+\varepsilon}{\sqrt{2}}|K^0\rangle + \frac{1-\varepsilon}{\sqrt{2}}|\bar{K}^0\rangle\right\}\right)$$

$$= \frac{1}{2(1+\varepsilon)}\left[(1+\varepsilon)\left(e^{-im_S t - \frac{\gamma_S t}{2}} + e^{-im_L t - \frac{\gamma_L t}{2}}\right)|K^0\rangle\right.$$

$$\left. + (1-\varepsilon)\left(e^{-im_L t - \frac{\gamma_L t}{2}} - e^{-im_S t - \frac{\gamma_S t}{2}}\right)|\bar{K}^0\rangle\right]$$

$$|\langle K^0|K^0(t)\rangle|^2 = \frac{1}{4(1+\varepsilon)^2}\left|\langle K^0|(1+\varepsilon)\left(e^{-im_S t - \frac{\gamma_S t}{2}} + e^{-im_L t - \frac{\gamma_L t}{2}}\right)|K_0\rangle\right.$$

$$\left.\cancel{+|K^0\rangle} + \langle K^0|(1-\varepsilon)\left(e^{-im_L t - \frac{\gamma_L t}{2}} - e^{-im_S t - \frac{\gamma_S t}{2}}\right)|\bar{K}_0\rangle\right|^2$$

$$= \frac{1}{4(1+\varepsilon)^2}\cdot(1+\varepsilon)^2\left(e^{-im_S t - \frac{\gamma_S t}{2}} + e^{-im_L t - \frac{\gamma_L t}{2}}\right)^2$$

$$= \frac{1}{4}e^{-\frac{t}{\tau_S}} + \frac{1}{4}e^{-\frac{t}{\tau_L}} + \frac{1}{2}e^{-\left(\frac{1}{\tau_S}+\frac{1}{\tau_L}\right)t}\cos(\Delta m t)$$

$$\langle \bar{K}^0 | \bar{K}^0(t) \rangle$$

$$|\bar{K}^0(t)\rangle = \frac{1}{2}(K_S - K_L) \cdot \sqrt{2(1+|\varepsilon|^2)} \cdot \frac{1}{1+\varepsilon}$$

$$= \frac{1}{2}\Big(\underbrace{e^{-im_S t - \frac{\gamma_S}{2}t}}_{a} |K_S\rangle - \underbrace{e^{-im_L t - \frac{\gamma_L}{2}t}}_{b} |K_L\rangle\Big) \cdot \sqrt{2(1+|\varepsilon|^2)} \cdot \frac{1}{1+\varepsilon} =$$

$$= \frac{1}{2}\Big\{ a \left[\frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{1+|\varepsilon|^2}}\left[(\varepsilon+1)|K^0\rangle - (1-\varepsilon)|\bar{K}^0\rangle\right]\right] - b\left[\frac{1}{\sqrt{2}} \frac{1}{\sqrt{1+|\varepsilon|^2}}\left[(1+\varepsilon)|K^0\rangle + (1-\varepsilon)|\bar{K}^0\rangle\right]\right]\Big\}$$

$$= \frac{1}{2}\left[\frac{a(\varepsilon+1)}{\sqrt{2}\cdot\sqrt{1+|\varepsilon|^2}} - \frac{b(\varepsilon+1)}{\sqrt{2}\cdot\sqrt{1+|\varepsilon|^2}}\right]|K^0\rangle - \frac{1}{2}\left[\frac{a(1-\varepsilon)}{\sqrt{2}\sqrt{1+|\varepsilon|^2}} + \frac{b(1-\varepsilon)}{\sqrt{2}\sqrt{1+|\varepsilon|^2}}\right]|\bar{K}^0\rangle =$$

$$= \frac{\sqrt{2}}{4}\frac{(\varepsilon+1)}{\sqrt{1+|\varepsilon|^2}}\left(e^{-im_S t - \frac{\gamma_S}{2}t} - e^{-im_L t - \frac{\gamma_L}{2}t}\right)|K_0\rangle - \underline{\frac{\sqrt{2}}{4}\cdot\frac{(1-\varepsilon)}{\sqrt{1+|\varepsilon|^2}}\left(e^{-im_S t - \frac{\gamma_S}{2}t} - e^{-im_L t - \frac{\gamma_L}{2}t}\right)|\bar{K}^0\rangle}$$

$$\langle \bar{K}^0 | \bar{K}^0(t) \rangle = -\frac{\sqrt{2}}{4}\frac{(1-\varepsilon)}{\sqrt{1+|\varepsilon|^2}}\left(e^{-im_S t - \frac{\gamma_S}{2}t} - e^{-im_L t - \frac{\gamma_L}{2}t}\right)$$

$$\langle K^0 | \bar{K}^0(t) \rangle = ?$$

$$|\bar{K}^0\rangle = \sqrt{\frac{1+|\varepsilon|^2}{2}} \cdot \frac{1}{1-\varepsilon} \left(|K_L\rangle - |K_S\rangle \right)$$

$$|\bar{K}^0(t)\rangle = \sqrt{\frac{1+|\varepsilon|^2}{2}} \cdot \frac{1}{1-\varepsilon} \cdot \left(|K_L(t)\rangle - |K_S(t)\rangle \right) = \sqrt{\frac{1+|\varepsilon|^2}{2}} \cdot \frac{1}{1-\varepsilon} \left(f_L(t) \cdot |K_L\rangle - f_S |K_S\rangle \right) =$$

$$= \sqrt{\frac{1+|\varepsilon|^2}{2}} \cdot \frac{1}{1-\varepsilon} \cdot \left(e^{-im_L t - \frac{\gamma_L}{2} t} |K_L\rangle - e^{-im_S t - \frac{\gamma_S}{2} t} |K_S\rangle \right)$$

$$|K_L\rangle = \frac{1}{\sqrt{2(1+|\varepsilon|^2)}} \left[(\varepsilon+1) |K^0\rangle + (1-\varepsilon) |\bar{K}^0\rangle \right]$$

$$|K_S\rangle = \frac{1}{\sqrt{2(1+|\varepsilon|^2)}} \left[(\varepsilon+1) |K^0\rangle - (1-\varepsilon) |\bar{K}^0\rangle \right]$$

$$\langle K^0 | K^0 \rangle = 1.$$

$$\langle K^0 | \bar{K}^0 \rangle = 0.$$

$$\langle K^0 | \bar{K}^0(t) \rangle = \sqrt{\frac{\cancel{1+|\varepsilon|^2}}{2}} \cdot \frac{1}{1-\varepsilon} \left[e^{-im_L t - \frac{\gamma_L}{2} t} \frac{1}{\sqrt{2(\cancel{1+|\varepsilon|^2})}} \cdot (\varepsilon+1) - e^{-im_S t - \frac{\gamma_S}{2} t} \frac{1}{\sqrt{2(\cancel{1+|\varepsilon|^2})}} \cdot (\varepsilon+1) \right] =$$

$$= \frac{1+\varepsilon}{2(1-\varepsilon)} \cdot \left[e^{-im_L t - \frac{\gamma_L}{2} t} - e^{-im_S t - \frac{\gamma_S}{2} t} \right]$$

$$\langle K_0 | K_0(t)\rangle = ?$$

$$|K_0\rangle = \frac{\sqrt{2}}{\sqrt{1+|\varepsilon|^2}} \cdot \frac{1+\varepsilon}{2} \left(|K^1\rangle + |K^2\rangle \right)$$

$$|K_0(t)\rangle = \frac{\sqrt{2}}{\sqrt{1+|\varepsilon|^2}} \cdot \frac{1+\varepsilon}{2} \left(|K^1(t)\rangle + |K^2(t)\rangle \right) = \frac{\sqrt{2}}{\sqrt{1+|\varepsilon|^2}} \cdot \frac{1+\varepsilon}{2} \left(\rho^1(t)|K^1\rangle + \rho^2(t)|K^2\rangle \right) =$$

$$= \frac{\sqrt{2}}{\sqrt{1+|\varepsilon|^2}} \cdot \frac{1+\varepsilon}{2} \cdot \left(e^{-i m_1 t - \frac{\Gamma_1}{2} t} |K^1\rangle + e^{-i m_2 t - \frac{\Gamma_2}{2} t} |K^2\rangle \right)$$

$$|K^1\rangle = \frac{\sqrt{2(1+|\varepsilon|^2)}}{2} \left[(1+\varepsilon)^{-1} |K_0\rangle + (1-\varepsilon)^{-1} |\bar{K}_0\rangle \right]$$

$$|K^2\rangle = \frac{\sqrt{2(1+|\varepsilon|^2)}}{2} \left[(1+\varepsilon)^{-1} |K_0\rangle - (1-\varepsilon)^{-1} |\bar{K}_0\rangle \right]$$

$$\langle K_0 | K_0\rangle = 1$$

$$\langle K_0 | \bar{K}_0\rangle = 0$$

$$\langle K_0 | K_0(t)\rangle = \frac{\sqrt{2}}{\sqrt{1+|\varepsilon|^2}} \cdot \frac{1+\varepsilon}{2} \left[e^{-i m_1 t - \frac{\Gamma_1}{2} t} \frac{\sqrt{2(1+|\varepsilon|^2)}}{2} (1+\varepsilon)^{-1} + e^{-i m_2 t - \frac{\Gamma_2}{2} t} \frac{\sqrt{2(1+|\varepsilon|^2)}}{2} (1+\varepsilon)^{-1} \right] =$$

$$= \frac{(1+\varepsilon)\,2}{1+\varepsilon} \left[e^{-i m_1 t - \frac{\Gamma_1}{2} t} + e^{-i m_2 t - \frac{\Gamma_2}{2} t} \right]$$

$$\langle \bar{K}^0 | K^0(t) = (*)$$

$$|K^0\rangle = \left(|K_S\rangle + |K_L\rangle\right) \sqrt{2(1+|\varepsilon|^2)}\, \frac{1}{1+\varepsilon} \quad \frac{1}{2}$$

$$|K_S\rangle = \frac{1}{\sqrt{1+|\varepsilon|^2}} \quad \frac{1}{\sqrt{2}} \quad \left\{ (1+\varepsilon)|K^0\rangle - (1-\varepsilon)|\bar{K}^0\rangle \right\}$$

$$|K_L\rangle = \frac{1}{\sqrt{1+|\varepsilon|^2}} \quad \frac{1}{\sqrt{2}} \quad \left\{ (1+\varepsilon)|K^0\rangle + (1-\varepsilon)|\bar{K}^0\rangle \right\}$$

$$K^0(t) = \left(|K_S(t)\rangle + |K_L(t)\rangle\right) \sqrt{2(1+|\varepsilon|^2)}\, \frac{1}{1-\varepsilon} \cdot \frac{1}{2} =$$

$$= \left(f_S(t)\,|K_S\rangle + f_L(t)|K_L\rangle\right) \sqrt{2(1+|\varepsilon|^2)}\, \frac{1}{1-\varepsilon} \cdot \frac{1}{2} =$$

$$= \left(f_S(t) \left[\cancel{\frac{1}{\sqrt{2(1+|\varepsilon|^2)}}} \left\{ (1+\varepsilon)|K^0\rangle - (1-\varepsilon)|\bar{K}^0\rangle \right\} \right] + \right.$$

$$\left. + f_L(t) \left[\cancel{\frac{1}{\sqrt{2(1+|\varepsilon|^2)}}} \left\{ (1+\varepsilon)|K^0\rangle + (1-\varepsilon)|\bar{K}^0\rangle \right\} \right] \right) \cancel{\sqrt{2(1+|\varepsilon|^2)}}\, \frac{1}{1-\varepsilon} =$$

$$= \frac{1+\varepsilon}{2(1-\varepsilon)} \left(f_S(t) + f_L(t)\right)|K^0\rangle + \frac{1}{2}\left(f_L(t) - f_S(t)\right)|\bar{K}^0\rangle$$

$$\left\{ \begin{array}{l} \langle \bar{K}^0 | K^0\rangle = 0 \\ \langle \bar{K}^0 | \bar{K}^0\rangle = 1 \end{array} \right\}$$

$$(*) = \frac{1}{2} \langle \bar{K}^0 | \bar{K}^0 \rangle \left(f_L(t) - f_S(t) \right) =$$

$$= \frac{1}{2} \left(e^{-im_L t} e^{-\frac{\gamma_L}{2}t} - e^{-im_S t} e^{-\frac{\gamma_S}{2}t} \right)$$