using the Expressions in ② inside ① we have ②

$$y_p(t) = \int (h^I(\tau)\cos 2\pi f_c\tau - h^Q(\tau)\sin 2\pi f_c\tau)\,(x^I(t-\tau)\cos 2\pi f_c(t-\tau) - x^Q(t-\tau)\sin 2\pi f_c(t-\tau))\,d\tau$$

$$= \int h^I(\tau)\,x^I(t-\tau)\cos 2\pi f_c\tau\cos 2\pi f_c(t-\tau)\,d\tau$$

$$+ \int h^Q(\tau)\,x^Q(t-\tau)\sin 2\pi f_c\tau\sin 2\pi f_c(t-\tau)\,d\tau$$

$$- \int h^I(\tau)\,x^Q(t-\tau)\cos 2\pi f_c\tau\sin 2\pi f_c(t-\tau)\,d\tau$$

$$- \int h^Q(\tau)\,x^I(t-\tau)\sin 2\pi f_c\tau\cos 2\pi f_c(t-\tau)\,d\tau.$$

$$= \frac{1}{2}\left[\int h^I(\tau)\,x^I(t-\tau)\,d\tau\right]\cos 2\pi f_c t$$

$$+ \frac{1}{2}\left[\int h^I(\tau)\,x^I(t-\tau)\cos 2\pi f_c(2\tau-t)\,d\tau\right]$$

$$+ \frac{1}{2}\left[\int h^Q(\tau)\,x^Q(t-\tau)\,d\tau\right]\left[-\cos 2\pi f_c t\right]$$

$$+ \frac{1}{2}\int h^Q(\tau)\,x^Q(t-\tau)\cos 2\pi f_c(2\tau-t)\,d\tau$$

$$- \frac{1}{2}\left[\int h^I(\tau)\,x^Q(t-\tau)\,d\tau\right]\left[\sin 2\pi f_c t\right]$$

$$+ \frac{1}{2}\int h^I(\tau)\,x^Q(t-\tau)\sin 2\pi f_c(2\tau-t)\,d\tau$$

$$- \frac{1}{2}\left[\int h^Q(\tau)\,x^I(t-\tau)\,d\tau\right]\left[\sin 2\pi f_c t\right]$$

$$- \frac{1}{2}\left[\int h^Q(\tau)\,x^I(t-\tau)\sin 2\pi f_c(2\tau-t)\,d\tau\right]$$

③