2) $C_X(t,\tau)$

$$= E\left(X(t,\omega)\,X(t-\tau,\omega)\right) = E\left(A(\omega)\sin(2\pi f_0 t + \Phi(\omega))\cdot A(\omega)\,\sin(2\pi f_0(t-\tau)) + \Phi(\omega)\right)$$

$$= \underbrace{E\left(A^2(\omega)\right)}_{\sigma^2} \cdot E\left(\sin(2\pi f_0 t + \Phi(\omega))\,\sin(2\pi f_0 t - \tau) + \Phi(\omega)\right)$$

$$= \sigma^2\,\frac{1}{2}\cdot E\left(\underbrace{\cos(2\pi f_0 \tau)}\, - \cos\left(2\pi f_0(2t-\tau) + 2\Phi\right)\right)$$

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$$= \sigma^2\cdot\frac{1}{2}\cos 2\pi f_0\tau - \underbrace{\frac{\sigma^2}{2}\,E\left(\cos 2\pi f_0(2t-\tau) + 2\Phi_{(\omega)}\right)}_{(*)}$$

$$(*) = -\frac{\sigma^2}{2}\int_0^{2\pi} \cos\left(2\pi f_0(2t-\tau) + 2\Phi\right)\cdot\frac{1}{2\pi}\,d\Phi$$

$$= -\frac{\sigma^2}{2}\,\frac{1}{2\pi}\left[\frac{1}{2}\sin 2\pi f_0(2t-\tau) + 2\Phi\right]_0^{2\pi}$$

$$= \frac{\sigma^2}{4\pi}\cdot\frac{1}{2}\left[\sin(2\pi f_0(2t-\tau) + 4\pi) - \sin 2\pi f_0(2t-\tau)\right]$$

$$= 0$$

$C_X(t,\tau) = \frac{\sigma^2}{2}$