EEL - 306

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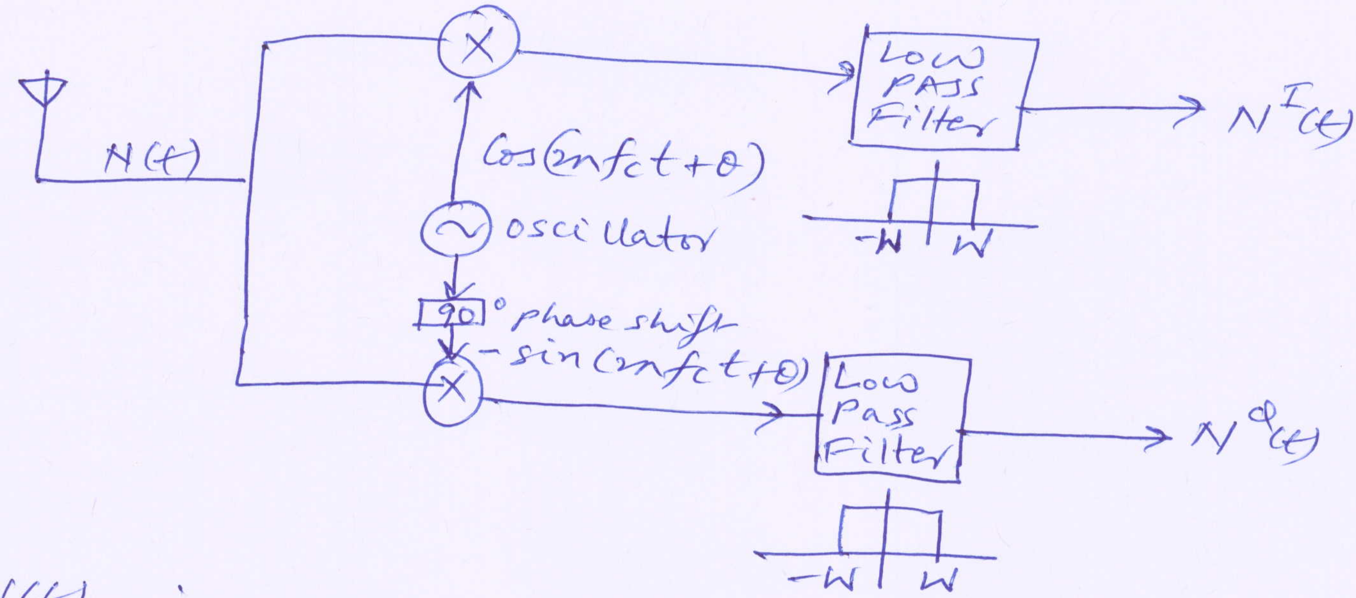
Tutorial # 3.

Q.1. A typical radio receiver is shown below



$N(t)$ is a white, W.S.S. real-valued process used to model noise in receiver circuit. $S_N(f) = \frac{N_0}{2}$. Let θ be uniformly distributed in $(-\pi, \pi]$, and independent of $N(t)$.

a) Find Expression for $R_{N^I}(\tau)$ and $R_{N^Q}(\tau)$. For what values of τ are $N^I(t)$ and $N^I(t-\tau)$ uncorrelated?

b) Find the cross correlation between $N^I(t)$ and $N^Q(t)$, i.e.,

$$R_{N^I,N^Q}(\tau) = E[N^I(t)\, N^Q(t-\tau)].$$

c) Consider the complex random process

$$\tilde{N}(t) \triangleq N^I(t) + j N^Q(t).$$

Find a relation between

$R_N(\tau)$ and $R_{\tilde{N}}(\tau) \triangleq E[\tilde{N}^*(t)\tilde{N}(t-\tau)]$.

Similarly find a relation between

$S_{\tilde{N}}(f)$ and $S_N(f)$.

Q.2) Let

$$Z \triangleq \int_{-\infty}^{\infty} W(t)\, h(t)\, dt$$

where $W(t)$ is a white W.S.S. random process and $h(t)$ is a deterministic signal, i.e., $R_W(\tau) = \frac{N_0}{2}\delta(\tau)$

Z is a random variable.

Find $E[Z]$ and $E[Z^2]$?

Find sufficiency conditions on $h(t)$ for $E[Z^2] < \infty$?

(all signals are real-valued)

Q.3.

let $Y(t) = X_1(t) + X_2(t)$,

be random process (complex-valued).

Let $R_{X_1}(\tau)$ and $R_{X_2}(\tau)$ be the autocorrelation function of $X_1(t)$ and $X_2(t)$ respectively (assume $X_1(t)$ and $X_2(t)$ to be W.S.S.).

Is $Y(t)$ also W.S.S in general?

If not, then what conditions are required for $Y_1(t)$ to be W.S.S?

Q.4) Problem 5.12 from book.

Q.5) Problem 5.18 from book