○ Review

• Lec. #1

(i) $x(t)$ is real-bandpass

f_c is chosen s.t. $\frac{B}{2} < f_c \le B$ where B is the maximum freq. component of $x(t)$

θ is chosen arbitrary in $(0, 2\pi)$

$\Rightarrow$ $\exists$ unique pair $x_c(t)$ & $x_s(t)$ s.t.

$$x(t) = x_c(t)\cos(2\pi f_c t + \theta) - x_s(t)\sin(2\pi f_c t + \theta)$$

where $x_c(t)$ & $x_s(t)$ are real baseband signals.

(ii) $x(t) \longleftrightarrow X(f)$

$x_+(t) \longleftrightarrow X_+(f) \triangleq 2X(f)u(f)$ ⟨pre-envelope / analytic signal⟩ of $x(t)$

$x_\ell(t) \longleftrightarrow X_\ell(f) \triangleq X_+(f+f_c)e^{-j\theta}$ complex envelope of $x(t)$

(iii) $X(f) = \frac{1}{2}\left(X_+(f) + X_+(-f)^*\right)$

$\Leftrightarrow$ $x(t) = \frac{1}{2}\left(x_+(t) + x_+(t)^*\right) = \mathrm{Re}\{x_+(t)\}$

$X_+(f) = X_\ell(f-f_c)e^{j\theta}$

$\Leftrightarrow$ $x_+(t) = x_\ell(t)e^{j(2\pi f_c t + \theta)}$

$\therefore$ $x(t) = \mathrm{Re}\{x_\ell(t)e^{j(2\pi f_c t + \theta)}\}$

(iv) $\mathrm{Re}\{x_\ell(t)e^{j(2\pi f_c t + \theta)}\} = x_c(t)\cos(2\pi f_c t + \theta) - x_s(t)\sin(2\pi f_c t + \theta)$

$\Rightarrow$ $\underbrace{\mathrm{Re}\{x_\ell(t)\} = x_c(t)}_{= \frac{x_\ell(t) + x_\ell(t)^*}{2}}$ $\quad$ $\underbrace{\mathrm{Im}\{x_\ell(t)\} = x_s(t)}_{= \frac{x_\ell(t) + x_\ell(t)^*}{2j}}$

$$\Rightarrow \quad X_c(f) = \frac{X_\ell(f) + X_\ell(-f)^*}{2}$$ conjugate symmetrical part of $X_\ell(f)$

$$jX_s(f) = \frac{X_\ell(f) - X_\ell(-f)^*}{2}$$ conjugate anti-symmetrical part of $X_\ell(f)$

· Lec. #2

(i) When $x(t) = \mathrm{Re}\{x_\ell(t)\, e^{j2\pi f_c t}\}$

$h(t) = \mathrm{Re}\{h_\ell(t)\, e^{j2\pi f_c t}\}$

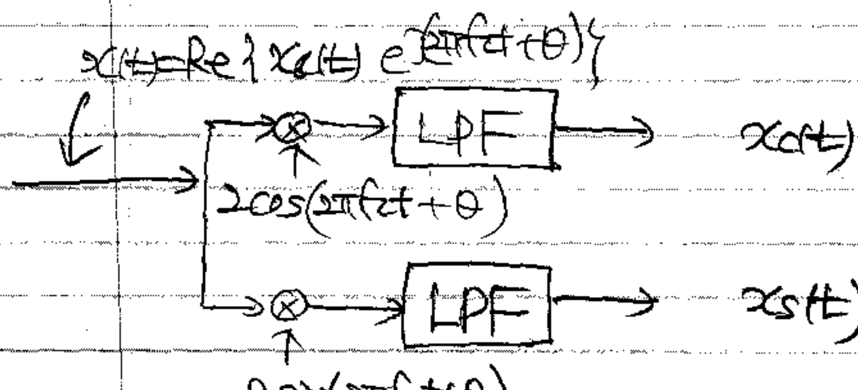
$y(t) = \mathrm{Re}\{y_\ell(t)\, e^{j2\pi f_c t}\}$

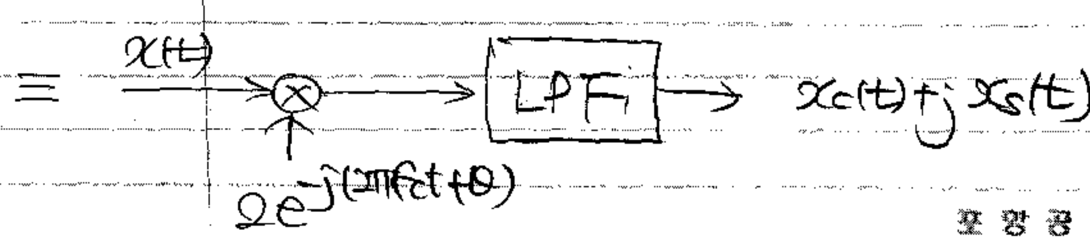
are all bandpass signals w/ complex envelopes $x_\ell(t)$, $h_\ell(t)$, and $y_\ell(t)$, respectively, we have

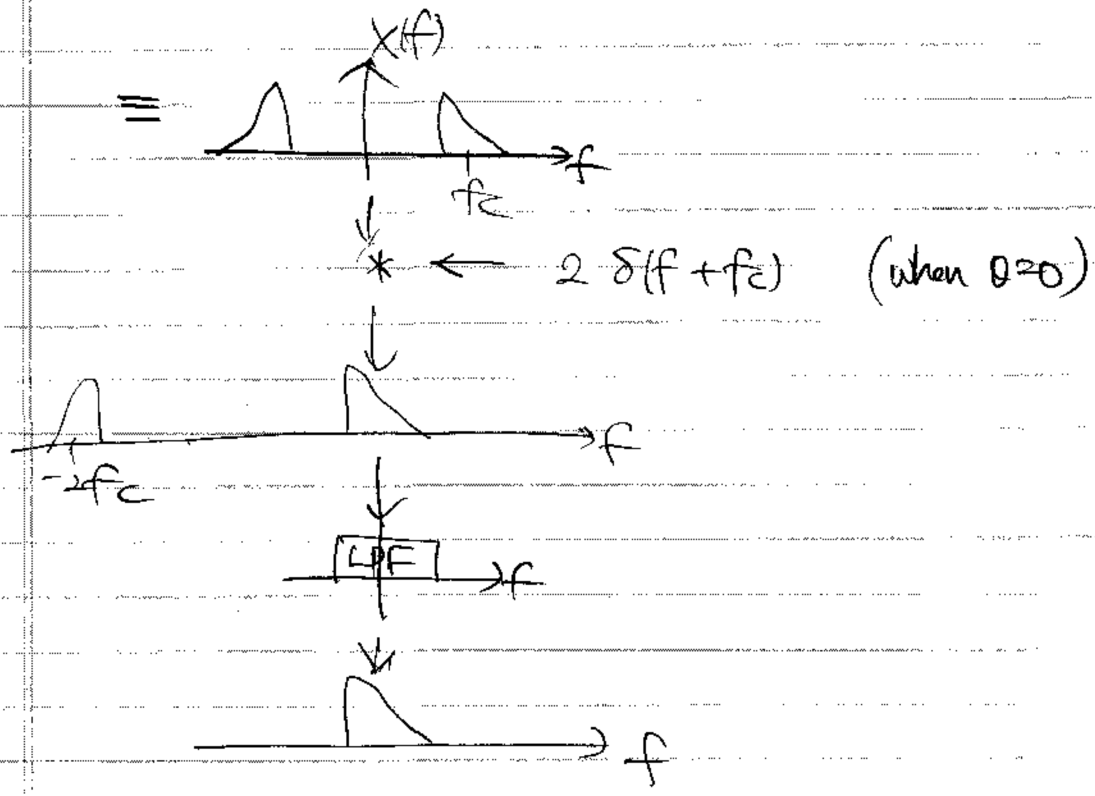
$$y(t) = x(t) * h(t)$$

$$\Longleftrightarrow \quad y_\ell(t) = \frac{1}{2}\, x_\ell(t) * h_\ell(t)$$

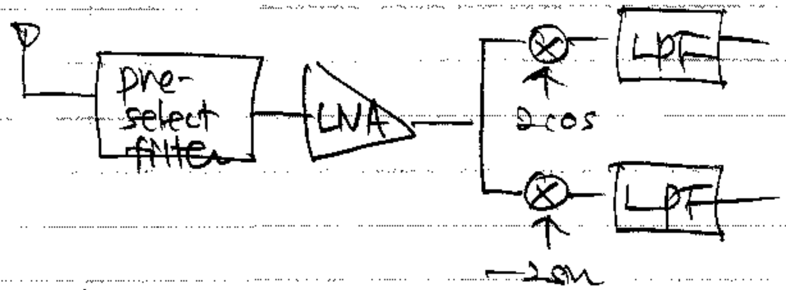
(ii) Quadrature demodulator





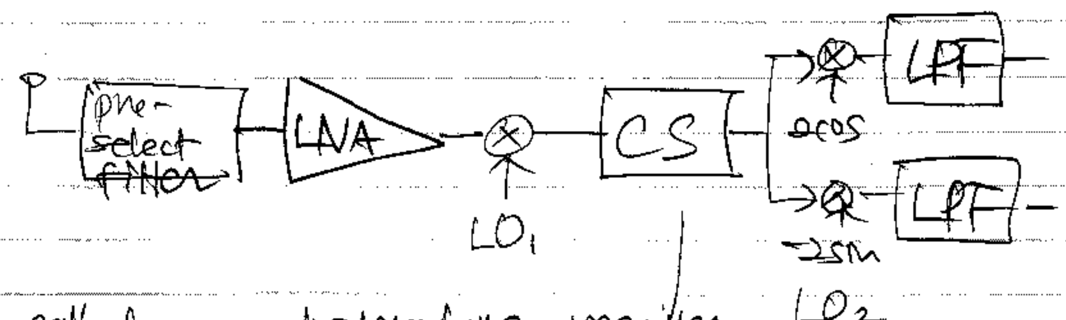


(iii)



called a homodyne receiver.
not popular. but under research

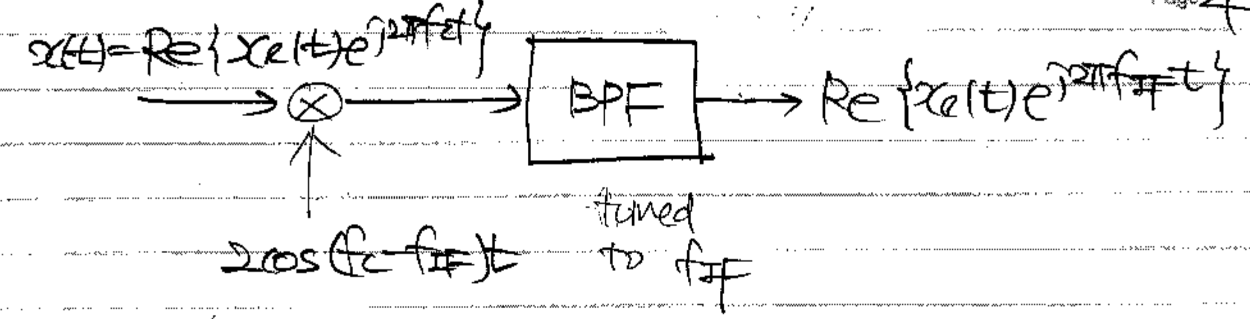
vs.

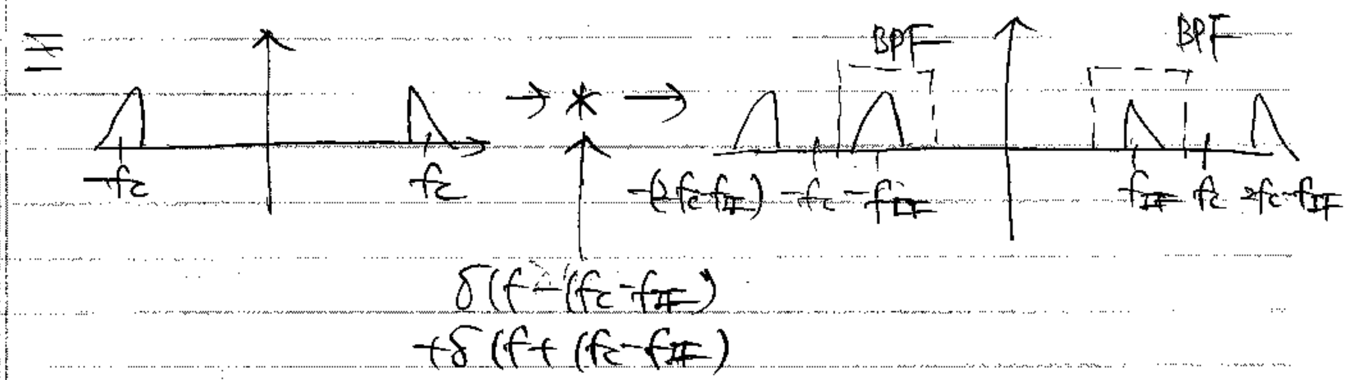


called a heterodyne receiver.
popular!

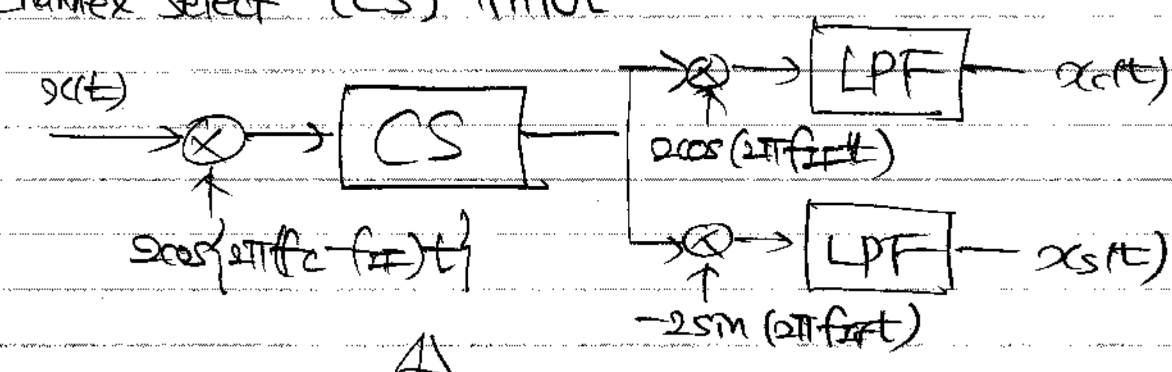
will be discussed here.

(iv) IF down-conversion





(V) Channel Select (CS) filter



Now you know why
we need this filter!

(vi) Image Band problem & Image Reject (IR) filter

If the input to the mixer contains only $x(t)$
then no problem.
However, in reality, the input may contain
unwanted signals in other band than f_c,
what happens to this unwanted signals when
they pass through the mixer-CS filter?