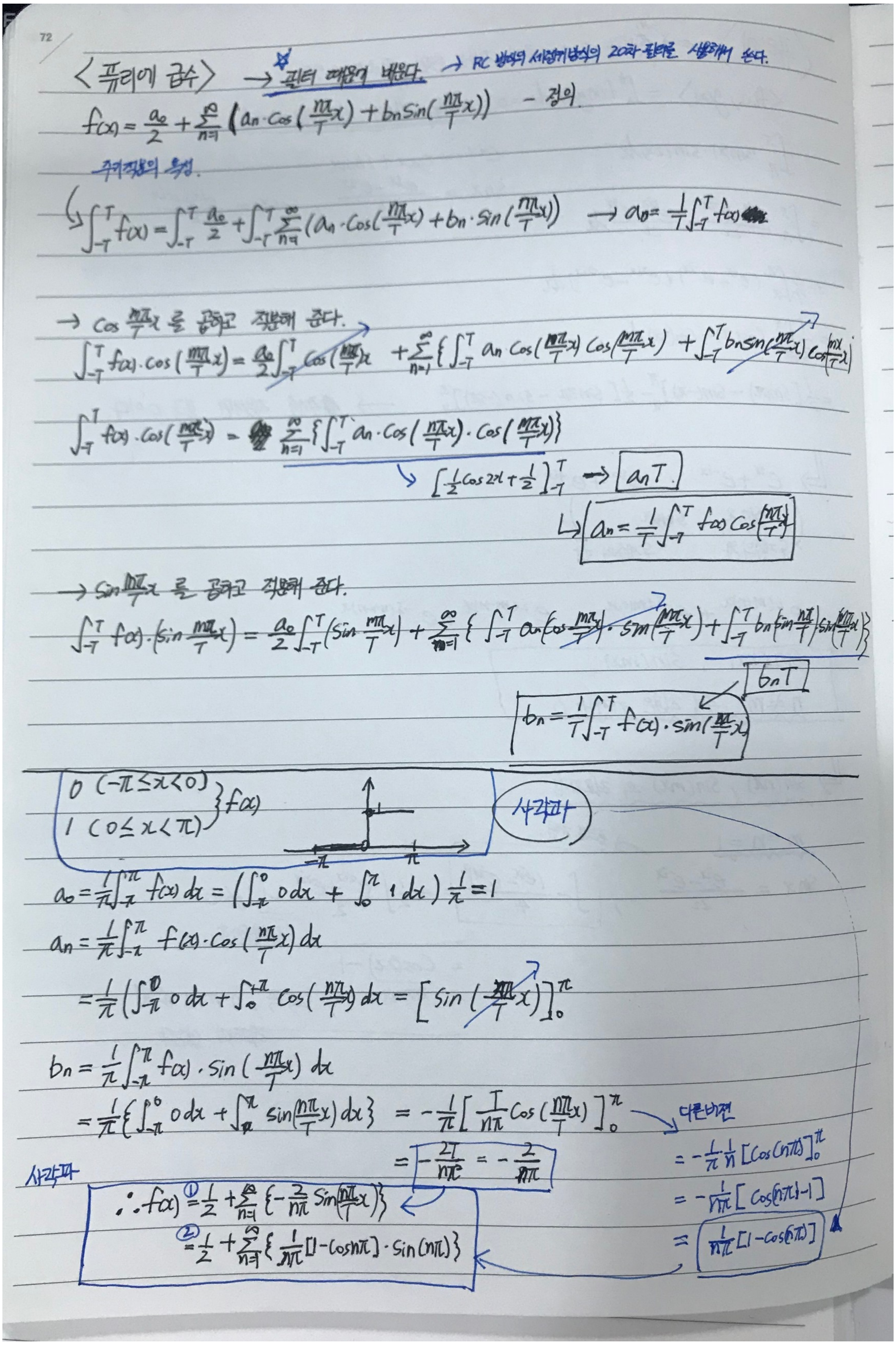
Xilinx Zynq FPGA,TI DSP,
MCU 기반의
프로그래밍 전문가 과정

날 짜 : 2018 . 5. 22

강사 – Innova Lee(이상훈)
gcccompil3r@gmail.com
학생 – 정한별
hanbulkr@gmail.com

수학

RC-RL 회로 Laplace 회로 회석.


72

〈퓨리에 급수〉 → 필터 때문에 배운다. → RC 방식의 서셉커방식의 20차 필터를 사용해서 쓴다.

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty}\left(a_n \cdot \cos\left(\frac{n\pi}{T}x\right) + b_n \sin\left(\frac{n\pi}{T}x\right)\right)$$ - 정의.

주기적분의 특성.

$$\int_{-T}^{T} f(x) = \int_{-T}^{T}\frac{a_0}{2} + \int_{-T}^{T}\sum_{n=1}^{\infty}\left(a_n \cdot \cos\left(\frac{n\pi}{T}x\right) + b_n \cdot \sin\left(\frac{n\pi}{T}x\right)\right) \rightarrow a_0 = \frac{1}{T}\int_{-T}^{T} f(x)$$

→ $\cos\frac{m\pi}{T}x$ 를 곱하고 적분해 준다.

$$\int_{-T}^{T} f(x)\cdot\cos\left(\frac{m\pi}{T}x\right) = \cancel{\frac{a_0}{2}\int_{-T}^{T}\cos\left(\frac{m\pi}{T}x\right)} + \sum_{n=1}^{\infty}\left\{\int_{-T}^{T} a_n \cos\left(\frac{n\pi}{T}x\right)\cos\left(\frac{m\pi}{T}x\right) + \cancel{\int_{-T}^{T} b_n \sin\left(\frac{n\pi}{T}x\right)\cos\left(\frac{m\pi}{T}x\right)}\right\}$$

$$\int_{-T}^{T} f(x)\cdot\cos\left(\frac{m\pi}{T}x\right) = \sum_{n=1}^{\infty}\left\{\int_{-T}^{T} a_n \cdot \cos\left(\frac{n\pi}{T}x\right)\cdot\cos\left(\frac{m\pi}{T}x\right)\right\}$$

$$\left[\frac{1}{2}\cos 2x + \frac{1}{2}\right]_{-T}^{T} \rightarrow \boxed{a_n T}$$

$$\boxed{a_n = \frac{1}{T}\int_{-T}^{T} f(x)\cos\left(\frac{n\pi}{T}x\right)}$$

→ $\sin\frac{m\pi}{T}x$ 를 곱하고 적분해 준다.

$$\int_{-T}^{T} f(x)\cdot\left(\sin\frac{m\pi}{T}x\right) = \frac{a_0}{2}\int_{-T}^{T}\left(\sin\frac{m\pi}{T}x\right) + \sum_{n=1}^{\infty}\left\{\cancel{\int_{-T}^{T} a_n\cos\frac{m\pi}{T}x \cdot \sin\left(\frac{n\pi}{T}x\right)} + \int_{-T}^{T} b_n \sin\frac{n\pi}{T}x \sin\left(\frac{m\pi}{T}x\right)\right\}$$

$$\boxed{b_n T}$$

$$\boxed{b_n = \frac{1}{T}\int_{-T}^{T} f(x)\cdot\sin\left(\frac{n\pi}{T}x\right)}$$

$$f(x) = \begin{cases} 0 & (-\pi \le x < 0) \\ 1 & (0 \le x < \pi) \end{cases}$$

사각파

$$a_0 = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)\,dx = \left(\int_{-\pi}^{0} 0\,dx + \int_{0}^{\pi} 1\,dx\right)\frac{1}{\pi} = 1$$

$$a_n = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)\cdot\cos\left(\frac{n\pi}{T}x\right)dx$$

$$= \frac{1}{\pi}\left(\int_{-\pi}^{0} 0\,dx + \int_{0}^{+\pi}\cos\left(\frac{n\pi}{T}x\right)dx\right) = \left[\sin\left(\cancel{\frac{n\pi}{T}}x\right)\right]_0^{\pi}$$

$$b_n = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)\cdot\sin\left(\frac{n\pi}{T}x\right)dx$$

$$= \frac{1}{\pi}\left\{\int_{-\pi}^{0} 0\,dx + \int_{0}^{\pi}\sin\left(\frac{n\pi}{T}x\right)dx\right\} = -\frac{1}{\pi}\left[\frac{T}{n\pi}\cos\left(\frac{n\pi}{T}x\right)\right]_0^{\pi}$$

$$= \boxed{-\frac{2T}{n\pi} = -\frac{2}{n\pi}}$$

다른버전

$$= -\frac{1}{\pi}\frac{1}{n}\left[\cos(n\pi)\right]_0^{\pi}$$

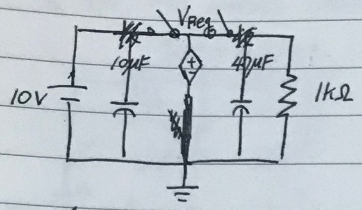
$$= -\frac{1}{n\pi}\left[\cos(n\pi) - 1\right]$$

$$= \boxed{\frac{1}{n\pi}\left[1 - \cos(n\pi)\right]}$$

사각파

$$\boxed{\begin{aligned} \therefore f(x) &\overset{①}{=} \frac{1}{2} + \sum_{n=1}^{\infty}\left\{-\frac{2}{n\pi}\sin\left(\frac{n\pi}{T}x\right)\right\} \\ &\overset{②}{=} \frac{1}{2} + \sum_{n=1}^{\infty}\left\{\frac{1}{n\pi}\left[1 - \cos n\pi\right]\cdot\sin(n\pi)\right\} \end{aligned}}$$

<7805 레귤레이터의 동작을 본다 . Laplace 활용>



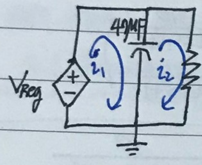
☆ 7805 레귤레이터의 동작을 본다.

0.000001초

0 ~ 1μS 사이에 5V 스위치 off
1 ~ 2μS 사이에 4.95V 스위치 on
2 ~ 3μS 사이에 5V 스위치 off
3 ~ 4μS 사이에 4.95V 스위치 on

$V_{Reg} = 5[H(t)] - 0.05[H(t-10^{-6})] + 0.05[H(t-2\times10^{-6})] - 0.05[H(t-3\times10^{-6})]$

$\Downarrow$



1. $V_{Reg} = \frac{q_1 - q_2}{C} = \frac{q_1 - q_2}{47} \cdot 10^6$

2. $i_2 R + \frac{q_2 - q_1}{C} = 0 \Rightarrow \cancel{1000} q_2' + \frac{q_2 - q_1}{47} \cdot 10^3 = 0$

$5[H(t) - 0.05[H(t-10^{-6})] = \frac{10^6}{47}(q_1 - q_2)$

$\mathcal{L}\{1번식\} = \frac{5}{s} - 0.05 \cdot \frac{1}{s} \cdot e^{-10^{-6} \cdot s} = \frac{10^6}{47}\{Q_1(s) - Q_2(s)\}$

$\mathcal{L}\{2번식\} = s \cdot Q_2(s) - q_2(0) + \frac{10^3}{47}\{Q_2(s) - Q_1(s)\}$

$Q_2(s) = \frac{\frac{10^3}{47}}{s + \frac{10^3}{47}} \cdot Q(s) = \frac{10^3}{47s + 10^3} Q(s)$

$\frac{5}{s} - 0.05 \frac{1}{s} e^{-10^{-6}s} = \frac{10^6}{47}\{Q(s) - \frac{10^3}{47s + 10^3} Q(s)\}$

$\frac{(47s + 10^3 - 10^3)}{47s + 10^3} Q_1(s)$

$\frac{5}{s} - 0.05 \frac{1}{s} e^{-10^{-6}} = \frac{10^6}{47} \cdot \frac{47s}{47s + 10^3} Q_1(s)$

$5 - 0.05 e^{-10^{-6}} = 10^6 \frac{s^2}{47s + 10^3} Q_1(s)$

$\boxed{Q_1(s)} = \frac{1}{10^6} \cdot \frac{47s + 10^3}{s^2}(5 - 0.05 e^{-10^{-6}s})$

$\frac{47s + 10^3}{s^2} = \frac{A}{s} + \frac{B}{s^2} \Rightarrow A = 47 \quad B = 10^3$

$q_1(t) = 10^{-6}(47 + 10^3 t) \mathcal{L}^{-1}(5 - 0.05 e^{-10^{-6}s})$

$= 10^{-6}(47 + 10^3 t) 5H[(t)] - 10^{-6}\{47 + 10^3(t - 10^{-6})\} \cdot 0.05 H[(t - 10^{-6})]$

$V_1(t) = \frac{1}{4} \times 10^6 \times \{q_1(t) - q_2(t)\}$

Q₁을 대입

$\boxed{Q_2(s)} = \frac{10^3}{47s + 10^3} \times \frac{1}{10^6} \frac{47s + 10^3}{s^2}(5 - 0.05 e^{-10^{-6}}s)$

$= \frac{1}{10^3} \cdot \frac{1}{s^2}(5 - 0.05 e^{-10^{-6}} \cdot s)$

$q_2(t) \Rightarrow \frac{1}{10^3} \cdot t \cdot 5H(t) - \frac{1}{10^3}(t - 10^{-6}) \cdot 0.05H(t - 10^{-6})$

$i_2(t) = \frac{1}{10^3} 5H[(t)] - \frac{1}{10^3} 0.05H(t - 10^{-6})$

$V_2(t) = i_2(t) \times 1k$

$= 5H[(t)] - 0.05H(t - 10^{-6})$

7805의 레귤레이터 내부동작.

<퓨리에>

⟨퓨리에⟩ → sin 사인과 cos은 주기 적분을 하면 무조건 0 이다.

$\langle f(x), g(x) \rangle = \int_a^b f(x)g(x)\,dx = 0$ 두 함수가 서로 직교 한다?

$\int_{-\pi}^{\pi} \sin(x)\cdot\sin(2x)\,dx$

$e^{ix} = \cos x + i\sin x$

$\sin x = \frac{e^{ix}-e^{-ix}}{2i}, \quad \cos x = \frac{e^{ix}+e^{-ix}}{2}$

$= \int_{-\pi}^{\pi} \frac{e^{ix}-e^{-ix}}{2i}\cdot\frac{e^{2ix}-e^{-2ix}}{2i}\,dx$

$= -\frac{1}{4}\int_{-\pi}^{\pi} (e^{ix}-e^{-ix})(e^{2ix}-e^{-2ix})\,dx$

$= \frac{1}{2}\int_{-\pi}^{\pi} \cos(x) - \cos(3x)\,dx$

$= \frac{1}{2}[\sin(\pi) - \sin(-\pi)]_{-\pi}^{\pi} - \frac{1}{6}[\sin 3\pi - \sin(-3\pi)]_{-\pi}^{\pi}$ → 주기를 적분하면 결국 0이다.

↳ $e^{ix}+e^{-ix}$ $\quad e^{3ix}+e^{-3ix}$

$\sin x$ $\quad \sin 2x$

두계수의 차 $\quad$ 두계수의 합

$e^{i(m+n)x} + e^{-i(m+n)x}, \quad e^{i(m-n)x} + e^{-i(m-n)x}$

$\boxed{\begin{array}{l}\sin(nx), \ \sin(mx) \\ n \neq m \text{ 주기 적분은 언제나 } 0\end{array}}$

↳ $\sin(nx)$, $\sin(mx)$ 의 직교판정

$m = n = 1$ → 곱해서 적분.

$\sin x = \frac{e^{ix}-e^{-ix}}{2i}$, $\boxed{\int -\frac{(e^{ix}-e^{-ix})^2}{4}} = -\frac{1}{2}\int \frac{e^{2ix}+e^{-2ix}}{2} - 1 \neq 0$

상수가 있어서.

$= \cos(2x) - 1$

주기함수 0

↳ 즉, $n=m$ 이 같으면 직교하지 않는다.

<퓨리에 급수>

<퓨리에 급수> → 필터 때문에 배운다. → RC 방식의 세렌키방식의 20차 필터를 사용해서 쓴다.

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty}\left(a_n \cdot \cos\left(\frac{n\pi}{T}x\right) + b_n \sin\left(\frac{n\pi}{T}x\right)\right)$$ – 정의.

주기적분의 특성.

$$\int_{-T}^{T} f(x) = \int_{-T}^{T}\frac{a_0}{2} + \int_{-T}^{T}\sum_{n=1}^{\infty}\left(a_n \cdot \cos\left(\frac{n\pi}{T}x\right) + b_n \cdot \sin\left(\frac{n\pi}{T}x\right)\right) \rightarrow a_0 = \frac{1}{T}\int_{-T}^{T} f(x)$$

→ $\cos\frac{m\pi}{T}x$ 를 곱하고 적분해 준다.

$$\int_{-T}^{T} f(x)\cdot\cos\left(\frac{m\pi}{T}x\right) = \cancel{\frac{a_0}{2}\int_{-T}^{T}\cos\left(\frac{m\pi}{T}x\right)} + \sum_{n=1}^{\infty}\left\{\int_{-T}^{T} a_n \cos\left(\frac{n\pi}{T}x\right)\cos\left(\frac{m\pi}{T}x\right) + \cancel{\int_{-T}^{T} b_n \sin\left(\frac{n\pi}{T}x\right)\cos\left(\frac{m\pi}{T}x\right)}\right\}$$

$$\int_{-T}^{T} f(x)\cdot\cos\left(\frac{m\pi}{T}x\right) = \sum_{n=1}^{\infty}\left\{\int_{-T}^{T} a_n \cdot\cos\left(\frac{n\pi}{T}x\right)\cdot\cos\left(\frac{m\pi}{T}x\right)\right\}$$

$$\left[\frac{1}{2}\cos 2x + \frac{1}{2}\right]_{-T}^{T} \rightarrow \boxed{a_n T}$$

$$\boxed{a_n = \frac{1}{T}\int_{-T}^{T} f(x)\cos\left(\frac{n\pi}{T}x\right)}$$

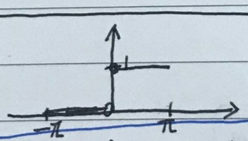
→ $\sin\frac{m\pi}{T}x$ 를 곱하고 적분해 준다.

$$\int_{-T}^{T} f(x)\cdot\left(\sin\frac{m\pi}{T}x\right) = \frac{a_0}{2}\int_{-T}^{T}\left(\sin\frac{m\pi}{T}x\right) + \sum_{n=1}^{\infty}\left\{\cancel{\int_{-T}^{T} a_n\left(\cos\frac{m\pi}{T}x\right)\cdot\sin\left(\frac{m\pi}{T}x\right)} + \int_{-T}^{T} b_n\left(\sin\frac{n\pi}{T}\right)\sin\left(\frac{m\pi}{T}x\right)\right\}$$

$$\boxed{b_n T}$$

$$\boxed{b_n = \frac{1}{T}\int_{-T}^{T} f(x)\cdot\sin\left(\frac{n\pi}{T}x\right)}$$

$$\left.\begin{matrix} 0 & (-\pi \le x < 0) \\ 1 & (0 \le x < \pi) \end{matrix}\right\} f(x)$$



사각파

$$a_0 = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)\,dx = \left(\int_{-\pi}^{0} 0\,dx + \int_{0}^{\pi} 1\,dx\right)\frac{1}{\pi} = 1$$

$$a_n = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)\cdot\cos\left(\frac{n\pi}{T}x\right)dx$$

$$= \frac{1}{\pi}\left(\int_{-\pi}^{0} 0\,dx + \int_{0}^{\pi}\cos\left(\frac{n\pi}{T}x\right)dx\right) = \left[\sin\left(\cancel{\frac{n\pi}{T}}x\right)\right]_{0}^{\pi}$$

$$b_n = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)\cdot\sin\left(\frac{n\pi}{T}x\right)dx$$

$$= \frac{1}{\pi}\left\{\int_{-\pi}^{0} 0\,dx + \int_{0}^{\pi}\sin\left(\frac{n\pi}{T}x\right)dx\right\} = -\frac{1}{\pi}\left[\frac{T}{n\pi}\cos\left(\frac{n\pi}{T}x\right)\right]_{0}^{\pi}$$

$$= \boxed{-\frac{2T}{n\pi} = -\frac{2}{n\pi}}$$

다른버전

$$= -\frac{1}{\pi}\frac{1}{n}\left[\cos(n\pi)\right]_{0}^{\pi}$$

$$= -\frac{1}{n\pi}\left[\cos(n\pi) - 1\right]$$

$$= \boxed{\frac{1}{n\pi}\left[1 - \cos(n\pi)\right]}$$

사각파

$$\therefore f(x) \overset{①}{=} \frac{1}{2} + \sum_{n=1}^{\infty}\left\{-\frac{2}{n\pi}\sin\left(\frac{n\pi}{T}x\right)\right\}$$

$$\overset{②}{=} \frac{1}{2} + \sum_{n=1}^{\infty}\left\{\frac{1}{n\pi}\left[1 - \cos n\pi\right]\cdot\sin(n\pi)\right\}$$