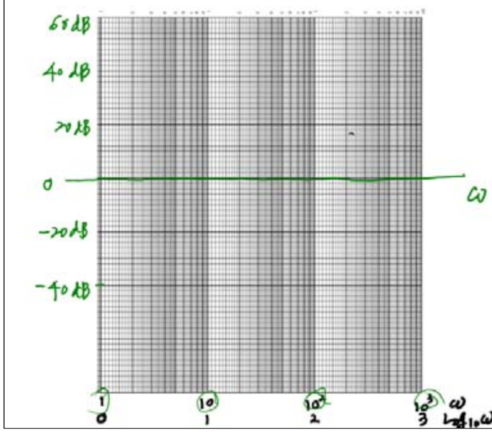
EE103 lect #19 Nov 13, 2017

HW #7 Posted
Qz 6 today

Sect 6.1, 6.2, 6.3

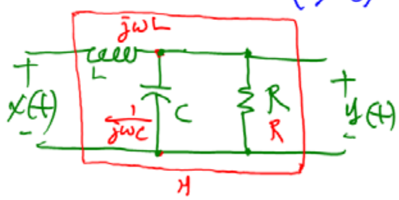
update on midterm scores

Prob 1-4	Prob 1-3 graded $\times \frac{100}{80}$
Avg 56.06	66.48
σ 21.31	23.79
100 highest	100 highest
90s 2, 40s 11	90s 14, 40s 3
80s 11, 30s 4	80s 17, 30s 5
70s 11, 20s 5	70s 10, 20s 4
60s 13, <20 7	60s 13, <20 4
50s 19	50s 13



N-th order Butterworth Filter

$$|H(\omega)| = \frac{1}{\sqrt{1+(\omega/\omega_c)^{2N}}}$$



$$H(\omega) = \frac{\frac{1}{j\omega C} \| R}{j\omega L + \frac{1}{j\omega C} \| R}$$

$$= \frac{1}{j\omega L\left(j\omega C + \frac{1}{R}\right) + 1}$$

$\frac{1}{j\omega C} \| R = \frac{\frac{1}{j\omega C} R}{\frac{1}{j\omega C} + R} = \frac{R}{1+j\omega RC} = \frac{1}{\frac{1}{R}+j\omega C}$

$$= \frac{1}{(1-\omega^2 LC) + j\omega \frac{L}{R}}$$

$$|H(\omega)| = \frac{1}{\sqrt{(1-\omega^2 LC)^2 + \left(\omega \frac{L}{R}\right)^2}}$$

For $L = 2R^2C$,

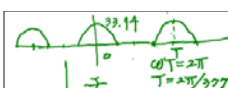
$$|H(\omega)| = \frac{1}{\sqrt{1-2\omega^2 LC + \omega^4 (LC)^2 + \omega^2\left(\frac{L}{R}\right)^2}}$$

where $\omega^2\left(\frac{L}{R}\right)^2 - 2\omega^2 LC = \omega^2 \frac{L^2}{R^2} - 2\omega^2 LC$

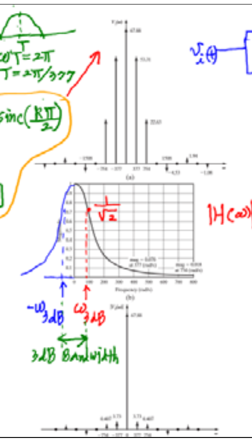
$= \omega^2 L\left(\frac{L}{R^2} - 2C\right) \overset{L=2R^2C}{=} \omega^2 L\left(\frac{2R^2C}{R^2} - 2C\right) = 0$

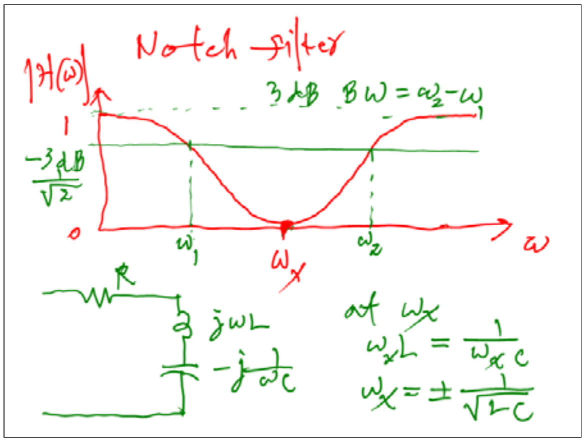
$$\Rightarrow |H(\omega)| = \frac{1}{\sqrt{1+\omega^4 (LC)^2}} = \frac{1}{\sqrt{1+\omega^4\left(\frac{1}{\omega_c}\right)^4}} = \frac{1}{\sqrt{1+\left(\omega/\omega_c\right)^4}}$$

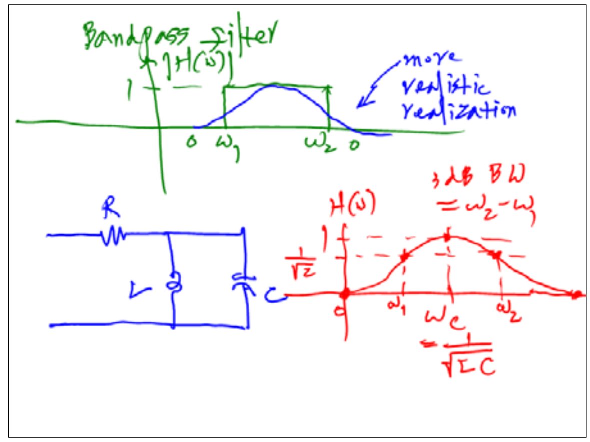
N=2, thus 2nd order Butterworth Filter

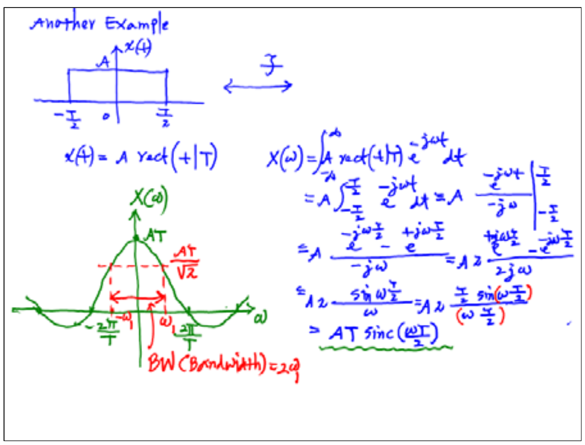


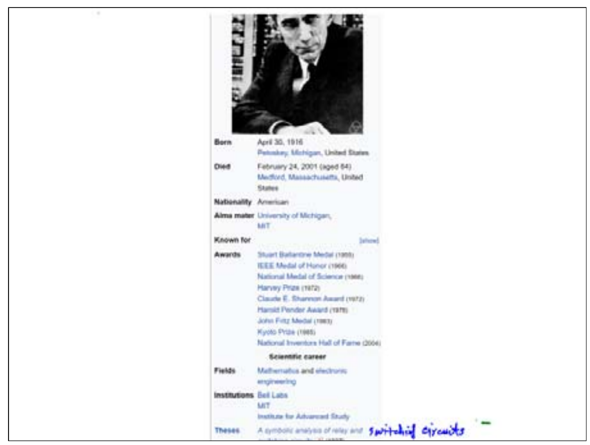
$$V_i(\omega) = 53.31 \sum_{k=-\infty}^{\infty} \text{sinc}\left(\frac{k\pi}{2}\right) \times \left[\delta(\omega-(k+1)377) + \delta(\omega-(k-1)377)\right]$$

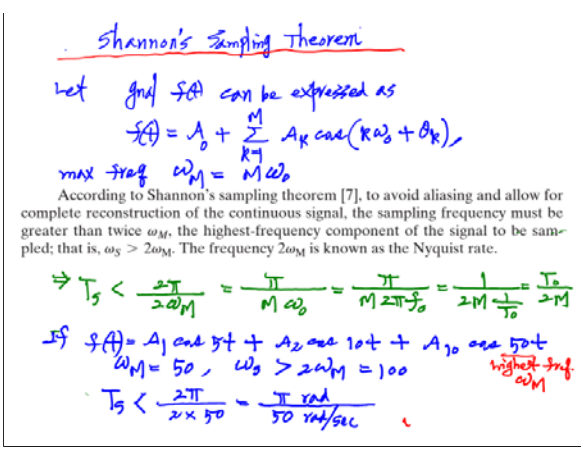












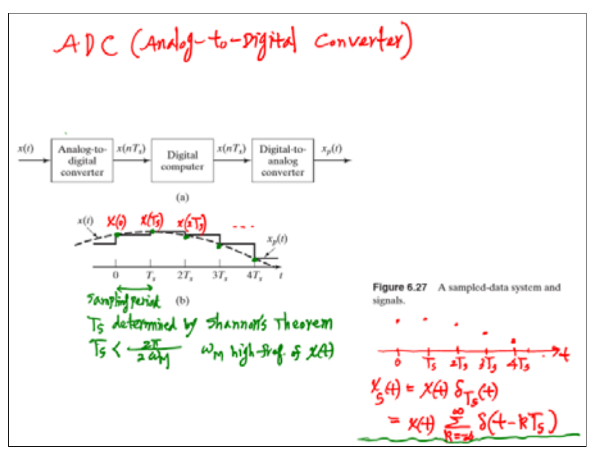
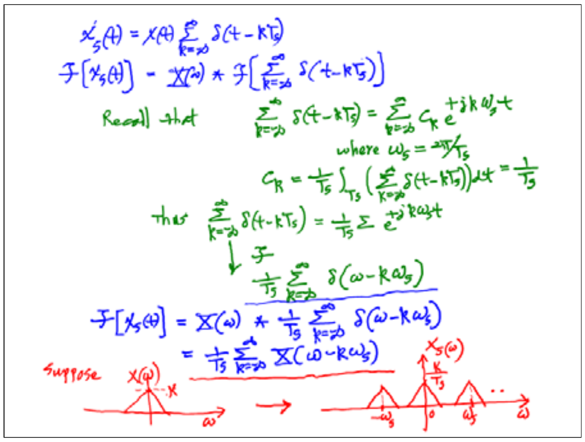
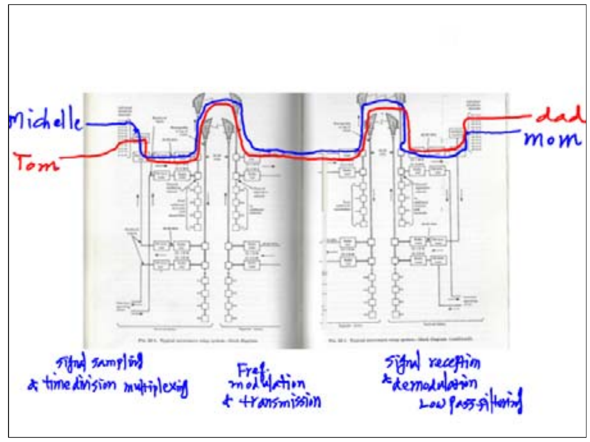


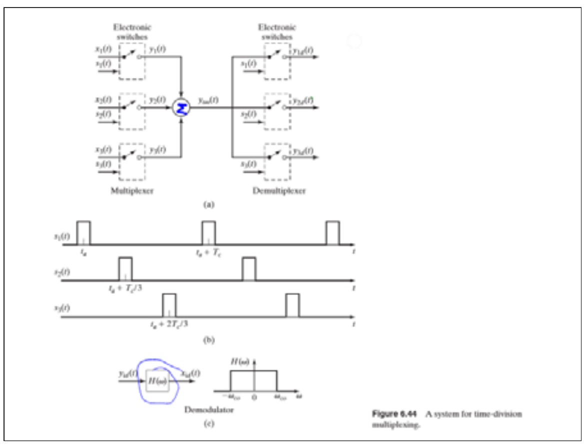
Figure 6.27 A sampled-data system and signals.



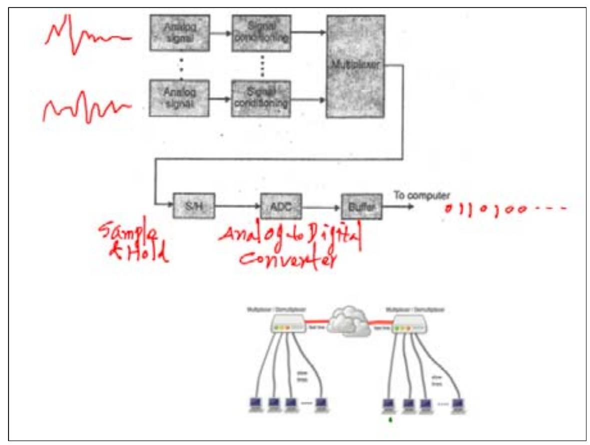
$x_s(t) = x(t)\sum_{k=-\infty}^{\infty}\delta(t-kT_s)$
$\mathcal{F}[x_s(t)] = X(\omega) * \mathcal{F}\left[\sum_{k=-\infty}^{\infty}\delta(t-kT_s)\right]$
Recall that $\sum_{k=-\infty}^{\infty}\delta(t-kT_s) = \sum_{k=-\infty}^{\infty} c_k e^{+jk\omega_s t}$
where $\omega_s = 2\pi/T_s$
$c_k = \frac{1}{T_s}\int_{T_s}\left(\sum_{k=-\infty}^{\infty}\delta(t-kT_s)\right)dt = \frac{1}{T_s}$
thus $\sum_{k=-\infty}^{\infty}\delta(t-kT_s) = \frac{1}{T_s}\sum e^{+jk\omega_s t}$
$\frac{1}{T_s}\sum_{k=-\infty}^{\infty}\delta(\omega-k\omega_s)$
$\mathcal{F}[x_s(t)] = X(\omega) * \frac{1}{T_s}\sum_{k=-\infty}^{\infty}\delta(\omega-k\omega_s)$
$= \frac{1}{T_s}\sum_{k=-\infty}^{\infty}X(\omega-k\omega_s)$
suppose



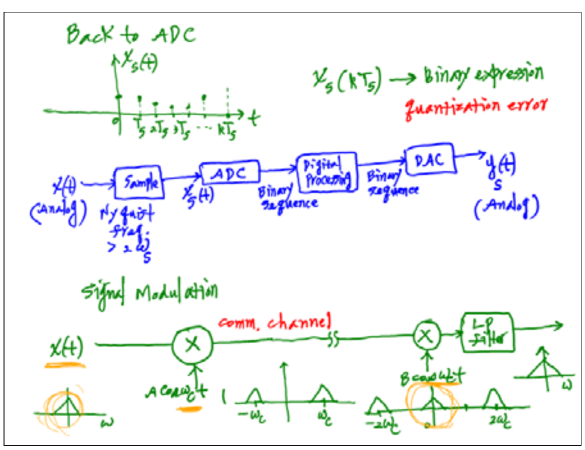
Michelle
Tom
dad
mom
signal sampling & time division multiplexing
Freq. modulation & transmission
signal reception & demodulation
Low pass filtering



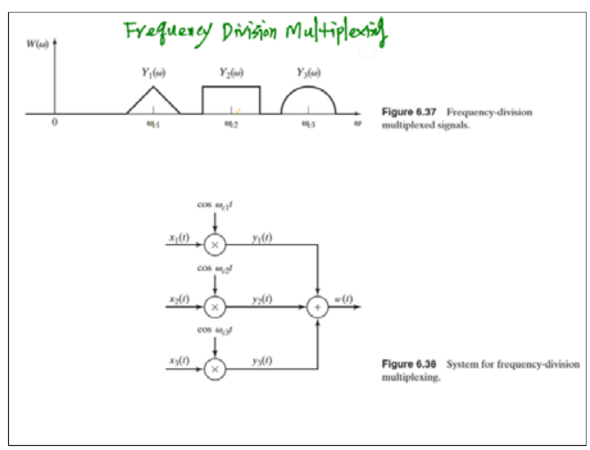
Electronic switches
Multiplexer
Demultiplexer
Demodulator
Figure 6.44 A system for time-division multiplexing.



Analog signal
Signal conditioning
Multiplexer
S/H
ADC
Buffer
To computer
0110100 - - -
Sample & Hold
Analog-to-Digital Converter



Back to ADC
$x_s(kT_s)$ → Binary expression
quantization error
Sample
ADC
Digital Processing
DAC
Binary sequence
(Analog)
Nyquist freq. $> 2\omega_s$
Signal Modulation
comm. channel
LP filter



Frequency Division Multiplexing
Figure 6.37 Frequency-division multiplexed signals.
Figure 6.38 System for frequency-division multiplexing.