DSP SS15 08.06.2015	**Tutorial 3**	Baris Cakar, 2541661 Julian Howes, 2550367

Exercise 1.1

Exercise 2.1

a)

If the highest frequency in the signal is $f_{max} = 5kHz$, then the minimum sample rate must be $f_s = 10kHz$. This also gives us the maximum value of T: $T_{max} = f_s^{-1} = 0.0001s$

b)

If the samplerate is $f_s = 10kHz$, then $T = f_s^{-1} = 0.0001s$. We use this to convert the angular frequency to an ordinary one as follows:

$\omega = \frac{\pi/8}{T} = 2\pi f_{cutoff}$

If we solve the above equation for f_{cutoff} with $T = 0.0001s$, we get $f_{cutoff} = 625Hz$

c)

Same as above with $T = 0.00005 \implies f_{cutoff} = 1250Hz$

Exercise 2.2

We can assume that upsampling by factor 3 and then downsampling by factor 3 has no effect on the signal, so it always holds $x[n] = x_e[n]$.

To determine whether $x[n]$ and $x_r[n]$ are equal we must thus only check whether the filter between $x_e[n]$ and $x_r[n]$ has any effect on $x_e[n]$. This is the case when $x_e[n]$ (or effectively $x[n]$) has impulses outside the range $[-\frac{\pi}{3}, \frac{\pi}{3}]$, which can be checked by looking at the Fourier transform of the corresponding signals.

Doing this, one can see that only the signal $x[n]$ from part b) will be affected by the filter, since the FT of a) and c) show impulses within the range of $[-\frac{\pi}{3}, \frac{\pi}{3}]$, while the FT of b) clearly has impulses at $-\frac{\pi}{2}, \frac{\pi}{2}$.

So, in short:

a)

$x[n] = cos(\frac{\pi n}{4}) \implies x[n] = x_r[n]$

b)

$x[n] = cos(\frac{\pi n}{2}) \implies x[n] \neq x_r[n]$

c)

$x[n] = [\frac{sin(\frac{\pi n}{8})}{\pi n}]^2 \implies x[n] = x_r[n]$