EECS 451 SOLUTIONS TO PROBLEM SET #6

1a. H(z)=$\frac{z-1}{z+1} \rightarrow H(e^{j\omega})=\boxed{\frac{e^{j\omega}-1}{e^{j\omega}+1}}=\frac{e^{j\omega/2}}{e^{j\omega/2}}\frac{e^{j\omega/2}-e^{-j\omega/2}}{e^{j\omega/2}+e^{-j\omega/2}}$=j $\tan(\omega/2)$.

1b. $H(e^{j0})=0$. $H(e^{j\pi/2})=\frac{j-1}{j+1}$=j=$1e^{j\pi/2}$. y[n]=$\boxed{4\cos(\frac{\pi}{2}n+\frac{3\pi}{4})}$.

2a. $\omega_1=2\pi\frac{100}{1200}=\frac{\pi}{6}$. Notch filter: $\{1,-2\cos(\frac{\pi}{6}),1\}=\{1,-\sqrt{3},1\}$.

$\omega_2=2\pi\frac{500}{1200}=\frac{5\pi}{6}$. Notch filter: $\{1,-2\cos(\frac{5\pi}{6}),1\}=\{1,\sqrt{3},1\}$.

Use h[n]=$\{1,-\sqrt{3},1\}*\{1,\sqrt{3},1\}=\boxed{\{1,0,-1,0,1\}}$.

2b. Keep zeros at $\{e^{\pm j\pi/6},e^{\pm j5\pi/6}\}$. Put poles at $\{0.9e^{\pm j\pi/6},0.9e^{\pm j5\pi/6}\}$.

$\boxed{y[n]-(0.9)^2y[n-2]+(0.9)^4y[n-4]=x[n]-x[n-2]+x[n-4]}$. 0.9→0.95,0.99 OK.

3a. $H(e^{j\omega})=0.5+0.29(e^{j\omega}+e^{-j\omega})-0.042(e^{j3\omega}+e^{-j3\omega})+0.005(e^{j5\omega}+e^{-j5\omega})$.

Simplify: $H(e^{j\omega})=\boxed{0.5+0.58\cos(\omega)-0.084\cos(3\omega)+0.01\cos(5\omega)}$. (3b) See below.

3c. Lowpass filter with cutoff frequency $\pi/4$. Little ripple but wide transition band.

4a. It's "Matlab–Breakfast of Champions" with an annoying tone added.

4b. See below. The single huge spike, which dwarfs the rest, is the tone.

4c. `C=-2*cos(2*pi*1000/24000);Y=filter([1 C 1],[1 0.9*C 0.81],X1);`

5a. It's "Matlab–Breakfast of Champions" with an annoying sound added.

5b. See below. The several spikes are harmonics of the interfering sound.

5c. `Y=filter([1 zeros(1,23) -1],[1 zeros(1,23) -0.9],X2);` This works!