Exercise 5: Embedded Systems

Group number (and name)
Name 1
Name 2
Name 3

Read these instructions first!

#	Questions	Write your answer in this column
1	Design a bandstop notch filter with the following properties: - Sampling rate = 22050 - Notch frequency = 1000+SSS/2 - Full bandwidth = 100+SSS/10 Verify your design from the amplitude response graph. Calculate how much the attenuation is if the interference frequency shifts 1Hz.	*Insert amplitude response graph to verify your design. Zoom the graph to check the center frequency and half width.* *Attenuation at (original f_{NOTCH} + 1) Hz = _____dB*
2	Determine the filter coefficients for the previous design as an 8-bit system and compare original floating point and new fixed point system responses.	*What happens to:* - *Stability* - *Notch frequency change (change of angle => physical frequency)* - *Attenuation at original notch frequency* - *Bandwidth change* - *Any other changes?*
3	Design an elliptic bandpass filter to match the following properties: - Sampling rate = 44100s^{-1} - Center frequency = SSS*15 - Passband bandwidth =	*Insert the frequency response graph here!*

	SSS*4 - 6'th order - Stopband attenuation 450dB - Maximum 1dB ripple in passband Verify your design from the amplitude response graphs.	
4	Determine how many bits should be used if the system (Q3) was implemented as a **direct form** filter on a fixed point system. Hint: compare the floating point system amplitude response with different fixed point system amplitude responses. Find the quantization level where the system still meets the required properties.	*Plot the amplitude responses of the original floating point and the quantized filters on the same graph.* *How many bits are needed in order to still meet the requirements.*
5	Determine how many bits should be used if the system (Q3) was implemented as a **second-order-system form** filter on a fixed point system. Hint: first, make sure that the model parameters are saved as SOS matrix in fdatool (default), then compare the floating point system amplitude response with different fixed point system amplitude responses. Find the quantization level where the system still meets the requirements.	*Plot the amplitude responses of the original floating point and the quantized filters on the same graph.* *How many bits are needed in order to still meet the requirements.*
6	How many channels a LPC1768 (or STM32L100C) can theoretically manage running the previously designed filter (SOS implementation). Hint: calculate how many clock	*Platform = ???* *Number of channels:_____* *Justify your answer!*

	cycles ARM Cortex M3 (LPC1768) will take for each ADD/SUB/MUL/MOVE... operation and estimate function call (=branch) overhead. Optionally, you may also try to implement your filter on your real platform by testing the processing speed on a forever loop, which calls your filter with dummy data and blinks a pin on each cycle. Measure the blinking frequency with an oscilloscope.	
7	Measure the performance of your laptop and estimate how many channels it can handle (on Matlab/Octave). Hint: easiest way to measure elapsed time is using functions tic() and toc(),	*Number of channels:_____* *Justify your answer!*