equation for the noise power. The scalings do not need to be considered. (3p)

5. The sampling frequency of the signal is to be lowered from 2048 Hz to 128 Hz. The frequency domain of interest lies between 0-45 Hz. Supposing that window method is used, calculate the lengths of the filters when 2-stage decimation is used. The specifications of the filters are
   - Passband ripple 0.01 dB
   - Stopband attenuation 60 dB (4p)

LAPLACE TRANSFORM TABLE

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$f(t) = \mathcal{L}^{-1}\{F(s)\}(t)$		$F(s) = \mathcal{L}\{f(t)\}(s) = \int_0^\infty e^{-st} f(t)dt$	
1		$\frac{1}{s}$,	$s > 0$
t^n,	n an integer	$\frac{n!}{s^{n+1}}$,	$s > 0$
e^{at}		$\frac{1}{s-a}$,	$s > a$
$\sin bt$		$\frac{b}{s^2+b^2}$,	$s > 0$
$\cos bt$		$\frac{s}{s^2+b^2}$,	$s > 0$
$e^{at} f(t)$		$F(s-a)$	
$e^{at} t^n$	n an integer	$\frac{n!}{(s-a)^{n+1}}$,	$s > a$
$e^{at} \sin bt$		$\frac{b}{(s-a)^2+b^2}$,	$s > a$
$e^{at} \cos bt$		$\frac{(s-a)}{(s-a)^2+b^2}$,	$s > a$
$t \sin bt$		$\frac{2bs}{(s^2+b^2)^2}$	$s > 0$
$t \cos bt$		$\frac{s^2-b^2}{(s^2+b^2)^2}$ *,	$s > 0$

Table 7.3 Summary of important features of common window functions.

Name of window function	*Transition width* (Hz) (*normalized*)	*Passband ripple* (dB)	*Main lobe relative to side lobe* (dB)	*Stopband attenuation* (dB) (*maximum*)	*Window function* $w(n), \lvert n \rvert \leq (N-1)/2$
Rectangular	$0.9/N$	0.7416	13	21	1
Hanning	$3.1/N$	0.0546	31	44	$0.5 + 0.5\cos\left(\frac{2\pi n}{N}\right)$
Hamming	$3.3/N$	0.0194	41	53	$0.54 + 0.46\cos\left(\frac{2\pi n}{N}\right)$
Blackman	$5.5/N$	0.0017	57	75	$0.42 + 0.5\cos\left(\frac{2\pi n}{N-1}\right) + 0.08\cos\left(\frac{4\pi n}{N-1}\right)$
	$2.93/N\ (\beta = 4.54)$	0.0274		50	$\frac{I_0(\beta\{1 - [2n/(N-1)]^2\}^{1/2})}{I_0(\beta)}$
Kaiser	$4.32/N\ (\beta = 6.76)$	0.002 75		70	
	$5.71/N\ (\beta = 8.96)$	0.000 275		90	

Table 7.2 Summary of ideal impulse responses for standard frequency selective filters.

	Ideal impulse response, $h_D(n)$	
Filter type	$h_D(n),\ n \neq 0$	$h_D(0)$
Lowpass	$2f_c \frac{\sin(n\omega_c)}{n\omega_c}$	$2f_c$
Highpass	$1 - 2f_c \frac{\sin(n\omega_c)}{n\omega_c}$	$1 - 2f_c$
Bandpass	$2f_2 \frac{\sin(n\omega_2)}{n\omega_2} - 2f_1 \frac{\sin(n\omega_1)}{n\omega_1}$	$2(f_2 - f_1)$
Bandstop	$1 - \left(2f_1 \frac{\sin(n\omega_1)}{n\omega_1} - 2f_2 \frac{\sin(n\omega_2)}{n\omega_2}\right)$	$1 - 2(f_2 - f_1)$