Astronomical Data Analysis Examples 5

1) For a human, the graph is tailing off sharply above 20 kHz, i.e. no frequency contribution above 20 kHz. According to the NSST, sampling at 40 kHz should allow perfect reconstruction of such a signal.

So the CD sampling rate of ~40 kHz should be adequate for humans (higher sampling rates would only benefit cats and dogs!)

[In fact CDs are sampled typically at 44.1 kHz]

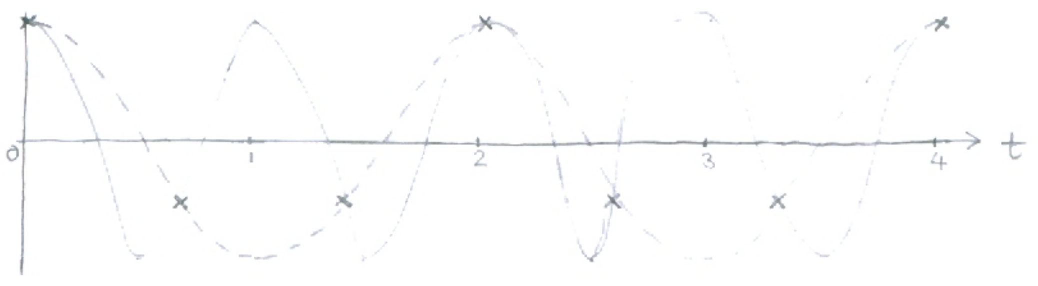
2) eq. (6.4)

$$h(t) = \Delta \sum_{k=-\infty}^{\infty} h_k \frac{\sin[2\pi f_c (t - k\Delta)]}{\pi(t - k\Delta)}$$

$$= \sum_{k=-\infty}^{\infty} \frac{\sin[2\pi f_c (t - k\Delta)]}{\pi[(t - k\Delta)/\Delta]}$$

$$= \sum_{k=-\infty}^{\infty} \frac{\sin[\pi (t - k\Delta)/\Delta]}{\pi[(t - k\Delta)/\Delta]} \quad \text{since } f_c = \frac{1}{2\Delta}$$

3)



Sampled values

t	0	$2/3$	$4/3$	$6/3$	$8/3$	$10/3$	$12/3$
$x(t)$	1	-0.5	-0.5	1	-0.5	-0.5	1

(crosses in sketch)

These values are also consistent with the dashed curve shown above.

4) a) Suppose the black is at 12 o'clock at $t=0$

 One frame ($\frac{1}{24}$th sec) later the wheel will have advanced through $\frac{1}{6}$th of a revolution to

 10 o'clock.

Then, in next frame, it has moved to 8 o'clock etc

$\Rightarrow$ apparent rotation rate is 4 rps

b) Similarly apparent rotation rate is 12 rps
(wheel will appear to flick back and forth between  and )

c) From $t=0$ to $t=\frac{1}{24}$ sec, wheel 'advances' to 
then to ,  etc

$\Rightarrow$ wheel appears to rotate 'backwards' at 6 rps.

d) Wheel appears stationary