



Examination Answer Books

12 Pages

Instructions to Candidates

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

Complete, fold and seal
(see note 2 below)

SURNAME: MILLER

FORENAME(S): NATHAN

1	Student Number	MIL14820987
2	Title of Examination Paper	Digital Signal Processing + Com
3	Module Code	M2X8518 ~~GOAC5000~~
4	Date and Time of Examination	11/5/18 9:30
5	Examination Venue	Main Hall
6	Seat Number	5
7	Number of Answer Books handed in	1 of 1

List the numbers of the questions you have attempted	Office Use
Q1	2
Q2	10
Q3	5
Q4	10
Q5	4
Total	31

52% ✓

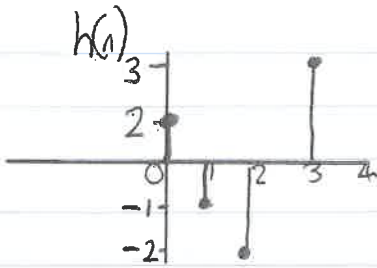
Template for Question 1 (Insert in Answer Booklet if used)

	0	1	2	3	4	5	6	7	8										
$x(n)$	2	-1	2	-1	0	0	0	0	0	✓									
$h(n)$	2	-1	-2	3	0	0	0	0	0	✓									
$h_0(x(n))$	4	~~1~~	-4	-3	0	0	0	0	0	+									
$h_1(x(n-1))$	0	-2	1	-2	1	0	0	0	0	✓									
$h_2(x(n-2))$	0	0	-4	3	-4	2	0	0	0	+									
$h_3(x(n-3))$	0	0	0	-6	3	6	-9	0	0	+									
$y(n) =$	4	-1	-7	-8	0	8	-9												

You have mixed up multiplies but close.

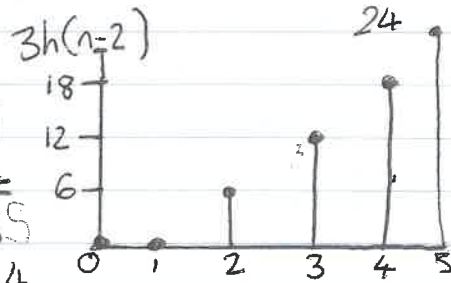
Student Name: Nathan Miller

① a)



b.)

n	0	1	2	3	4	5
$h(n)$	2	-1	-2	3	0	0
$h(n-2)$	0	0	2	4	6	8
$3h(n-2)$	0	0	6	12	18	24



c) On attached template sheet



$$(2) a) \delta p = \log_{10}^{-1} \left[\frac{0.1}{20} \right] - 1 = 0.0116$$

$$\delta s = \log_{10}^{-1} \left[\frac{50}{20} \right] = 316.23$$

$$F_p = f_p / f_s = \frac{10000}{40000} = 0.25$$

$$\Delta F = \frac{\Delta f}{f_s} = \frac{300}{40000} = 7.5 \times 10^{-3} = 0.0075$$

$$\Omega_c = 2\pi (0.25 + (0.5 \times 0.0075)) = 1.594$$

Most suitable window = Hamming

$$N = \frac{3.3}{\Delta F} = \frac{3.3}{0.0075} = 440 \text{ must be odd so } (441)$$

$$b) \omega(n) = 0.54 - 0.46 \cos \left[\frac{2\pi \times 6}{440} \right] = 0.08$$

$$2 F_c \frac{\sin(n\Omega_c)}{n\Omega_c} = 2 \times F_c \times \frac{\sin(6 \times 1.594)}{6 \times 1.594} = 2 \times F_c \times \frac{\sin(9.564)}{9.564}$$

$$= 2 \times F_c \times 0.017 = F_c \times 0.0347$$

Filter coefficient value $\therefore = 0.08 * (F_c \times 0.0347)$
for $n=6$

$$F_c = ?$$

use Radians ✓

③ a) 1 2 3 4 5 6 7 8 9 10 11 12 13
 $P_1 = d_1 + d_2 + d_3 + d_4 + d_5 + d_6 + d_7 + d_8 + d_9 + d_{10} + d_{11} + d_{12} + d_{13}$

$P_4 = d_1 + d_2 + d_3 = 1$
 $P_3 = d_1 + d_2 + d_4 = 0$
 $P_2 = d_1 + d_3 + d_4 = 0$
 $P_1 = d_2 + d_3 + d_4 = 1$

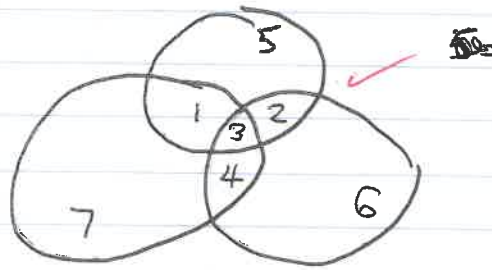
$P_1 = \text{OK}, 1+1+0+1+0+0+1=4 \checkmark$
 $P_2 = \text{Error}, 1+0+0+0+0+1=3 \times$
 $P_3 = \text{Error}, 1+0+1+0+0+1+0+0=3 \times$
 $P_4 = \text{OK}, 1+0+1+0+0+0+1+1=4 \checkmark$

① ✓

Therefore the error is in bit #12
 Corrected =

1 0 1 0 0 0 1 1 0 1 0 1 1

b.)



$1 = 1$
 $2 = 0$
 $3 = 1$
 $4 = 0$
 $5 = 1 + 3 + 2 = 0$
 $6 = 2 + 3 + 4 = 1$
 $7 = 1 + 3 + 4 = 0$

Check = $P_3 = d_1 + d_2 + d_4 = 0$
 $P_2 = d_1 + d_3 + d_4 = 0$
 $P_1 = d_2 + d_3 + d_4 = 0$

= 1 0 1 0 0 1 0 ✓

14 ✓

(4) a.) 14000 samples per second

$$b.) D.T = 3 \cos\left(\frac{2000\pi}{6000}n\right) + 6 \cos\left(\frac{14000\pi}{6000}n\right) - 4 \sin\left(\frac{4000\pi}{6000}n\right)$$

$$= 3 \cos 2\pi\left(\frac{1}{6}\right)n + 6 \cos 2\pi\left(1 + \frac{1}{6}\right)n - 4 \sin 2\pi\left(\frac{2}{3}\right)n$$

$$= 9 \cos 2\pi\left(\frac{1}{6}\right)n - 4 \sin 2\pi\left(\frac{1}{3}\right)n$$

$$c.) x(t) = 9 \cos 2\pi\left(\frac{6000}{6}\right)t - 4 \sin 2\pi\left(\frac{6000}{3}\right)t$$

$$= 9 \cos \pi\left(\frac{12000}{6}\right)t - 4 \sin \pi\left(\frac{12000}{3}\right)t$$

$$= 9 \cos(2000\pi t) - 4 \sin(4000\pi t)$$

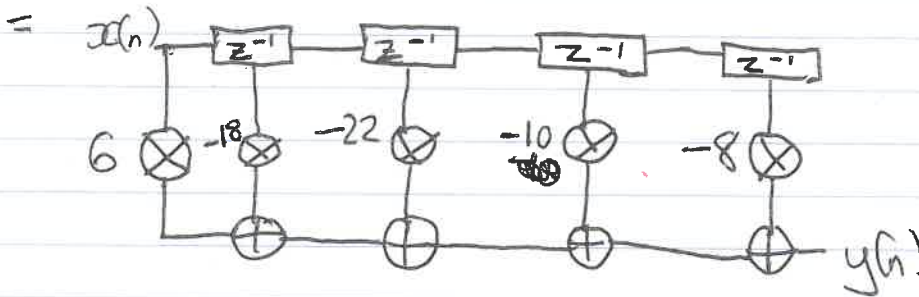
Comparing with the original you can see that the higher frequency ~~6000Hz~~ has now been lost

3 ✓

4 ✓

3 ✓

$$\begin{aligned}
 \textcircled{5} \text{ a) } H(z) &= (3+z^{-2})(1-4z^{-1})(2+z^{-1}) \\
 &= (3-12z^{-1}+z^{-2}-4z^{-3})(2+z^{-1}) \\
 &= 6+6z^{-1}-24z^{-1}-24z^{-2}+2z^{-2}+2z^{-3}-12z^{-3}-8z^{-4} \\
 \therefore &= 6-18z^{-1}-22z^{-2}-10z^{-3}-8z^{-4}
 \end{aligned}$$



(4) ✓

$$\begin{aligned}
 \text{b) b) } x(n)(2+z^{-1}) + (6+z^{-2}) &= y(n)(2+z^{-1}) + (3+z^{-2}) \\
 \cancel{(2+z^{-1})} (2+z^{-1}) + (4+z^{-2}) + 2 &+ (2+z^{-1}) + (3+z^{-2}) \\
 &= 2 + 4z^{-1} + 7z^{-2}
 \end{aligned}$$

X