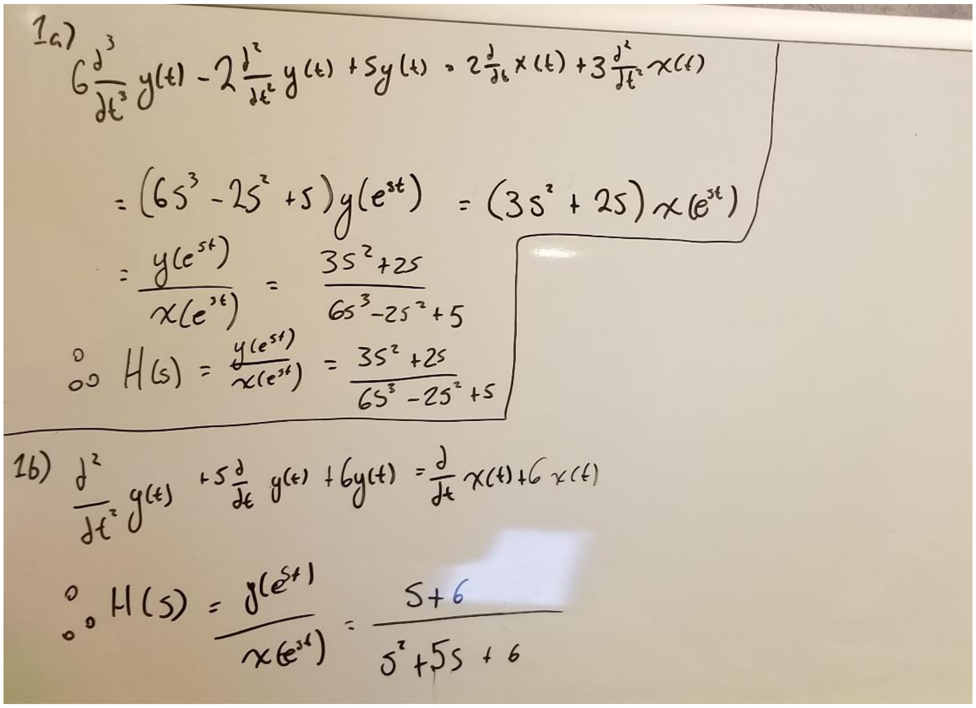
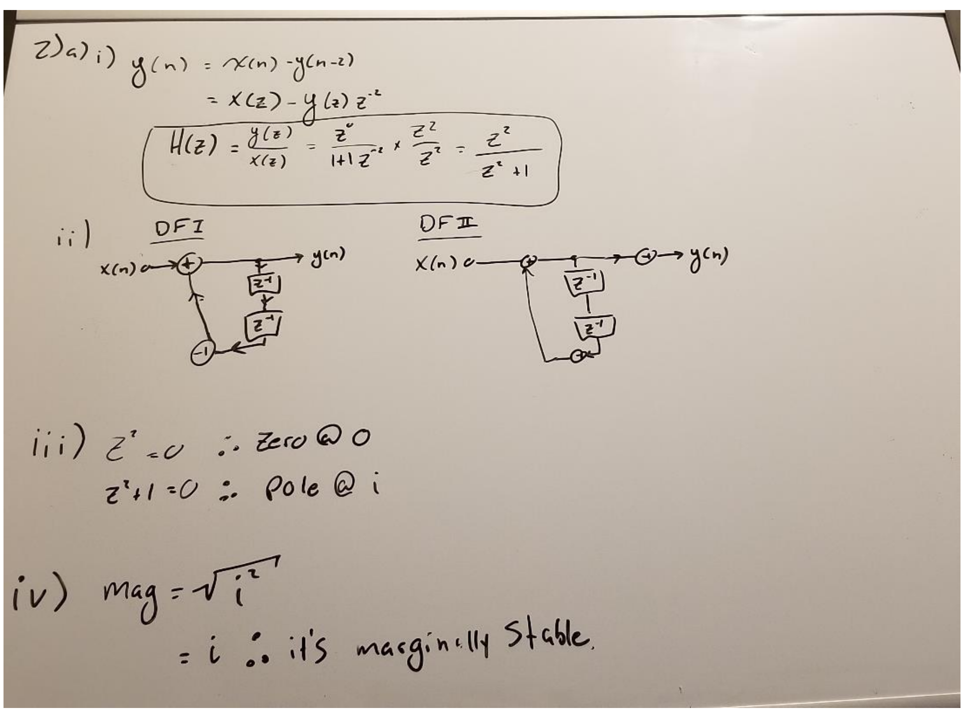
DSP Lab 5 – Graeme Judge

Question 1)



Question 2) a)



Question 2) b)

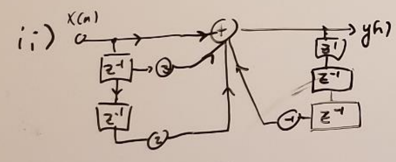
2)b) i) $y(n) = x(n) - 3x(n-1) + 2x(n-2) - y(n-3)$

$= X(z) - 3X(z)z^{-1} + 2X(z)z^{-2} - Y(z)z^{-3}$

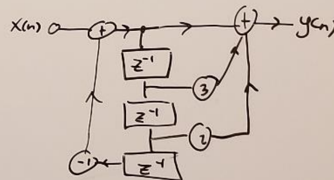
$H(z) = \frac{Y(z)}{X(z)} = \frac{1+3z^{-1}+2z^{-2}}{1+z^{-3}} \times \frac{z^{-3}}{z^{-3}}$

$$\boxed{H(z) = \frac{z^3+3z^2+2z}{z^3+1}}$$

ii)



DFI



iii) $\frac{(z)(z+2)(z+1)}{z^3+1}$ Zeros @ 0, -1, -2

Poles @ -1

iv) mag of poles $= \sqrt{1^2}$

$= 1$ ∴ marginally stable since mag≤1

Question 2) c)

2)c) i) $y(n) = x(n) + x(n-1) + x(n-3) + x(n-4) - y(n-2)$

$= \frac{1+z^{-1}+z^{-3}+z^{-4}}{1+z^{-2}} \cdot \frac{z^4}{z^4}$

$= \frac{z^4+z^3+z^1+1}{z^4+z^2}$ * Synthetic division

-1	1	1	0	1	1
	↓	-1	0	0	-1
-1	1	0	0	1	$\boxed{0}$
	↓	-1	1	-1	
	1	-1	1	$\boxed{0}$	

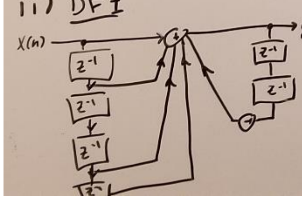
$(z+1)(z+1)(z^2-z+1)$ ← quad formula

$= \frac{-1+\sqrt{3}i}{2}$ or $\frac{-1-\sqrt{3}i}{2}$

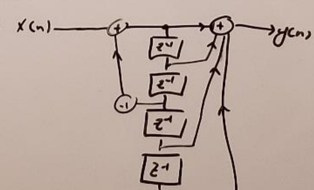
$z = -0.5+0.87i$ or $-0.5-0.87i$

$$\boxed{\therefore H(z) = \frac{(z+1)(z+1)(z+0.5-0.87i)(z+0.5+0.87i)}{z^2(z^2+1)}}$$

ii) DFI



DFII



2c) iii) Zeros @ $-1, -1, -0.5+0.87i, -0.5-0.87i$

Poles @ $0, i$

iv) $mag = i$ ∴ marginally stable

Question 3)

3) $$H(z) = \frac{z^2+0.3z+1}{z^2-0.3z+0.8}$$

a) → $-z$ exponents then $\times z^-$ (largest exp)

$$H(z) = \frac{z^2+0.3z+1}{z^2-0.3z+0.8} \times \frac{z^{-2}}{z^{-2}} = \frac{1-0.3z^{-1}-z^{-2}}{1-0.3z^{-1}-0.8z^{-2}}$$

b) Find poles

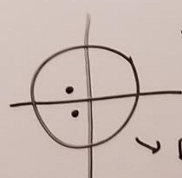
$$z = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

$$z = \frac{-0.3 \pm \sqrt{0.09-4(1)(0.8)}}{2(1)}$$

$z = -0.15+0.88i$ $\quad z = 0.15+0.88i$

$mag = \sqrt{0.15^2+0.88^2}$

$\boxed{= 0.89}$



→ Both inside

∴ System is stable