MAY 2022 [ESE] Pat 2018

T.Y. E&TC sem II

Digital Signal Processing ETUA32183 Soln set III

Q.1. a) Yes. Impulse response is symmetric. — (1)

$$\angle H(\omega) = -\frac{3}{2}\omega \quad \text{— (3)}$$

b) $$h(n) = \frac{1}{M}\left[H(0) + 2\sum_{k=1}^{\frac{M-1}{2}} \text{Re}\left[H(k)\, e^{j2\pi nk/M}\right]\right] \quad \text{— (2)}$$

$$h(n) = \{0.073, -0.11, -0.06, 0.32, 0.56, 0.32, -0.06, -0.11, 0.073\} \quad \text{— (4)}$$

c) $$h_d(n) = \{-0.2652, 0.022, 0.3183, 0.022, -0.2652\} \quad \text{— (2)}$$

$$\omega(n) = \{0.25, 0.75, 1, 0.75, 0.25\} \quad \text{— (2)}$$

$$h(n) = \{-0.066, 0.0162, 0.3183, 0.0162, -0.066\} \quad \text{— (2)}$$

Q.2. a) $$\Omega_c = \frac{0.65}{T} \quad \text{— (1)}$$

$$H(s) = \frac{0.65/T}{s + 0.65/T} \quad \text{— (1)}$$

$$H(z) = \frac{0.65/T}{\frac{2}{T}\left(\frac{z-1}{z+1}\right) + \frac{0.65}{T}} \quad \text{— (1)}$$

$$H(z) = \frac{0.245\left(1 + e^{-j\omega}\right)}{1 - 0.509\, e^{-j\omega}} \quad \text{— (1)}$$

c) $$H(z) = \frac{(z+1)(z+0.2)}{(z+0.5)(z-0.4)}$$

$$H(z) = \frac{0.82}{z+0.5} + \frac{0.17}{z-0.4}$$

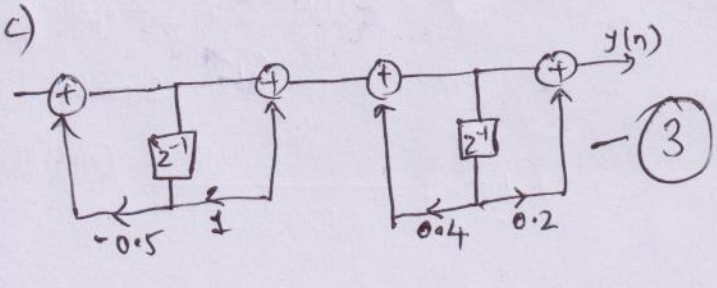
b) $\Omega_p = 2$ rad/sec $\quad \Omega_s = 4.83$ rad/sec — (2)

$N = 3$ — (1) $\quad \Omega_c = 2.55$ rad/sec — (1)

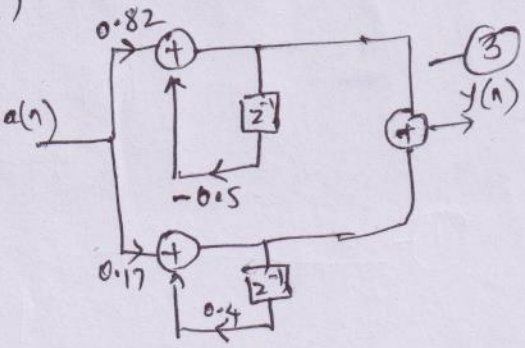
$$H(s) = \frac{2.55}{s + 2.55} \cdot \frac{2.55^2}{s^2 + 2.555 + 2.55^2} \quad \text{— (1)}$$

$$H(z) = \frac{2.55}{\left(\frac{z-1}{z+1}\right) + 2.55} \cdot \frac{2.55^2}{\left(\frac{z-1}{z+1}\right)^2 + 2.55\left(\frac{z-1}{z+1}\right) + 2.55^2} \quad \text{— (1)}$$

c)



— (3)



— (3)

Q 3 a) Number of samples = 10000

Frame size = 1000

hop size = 500

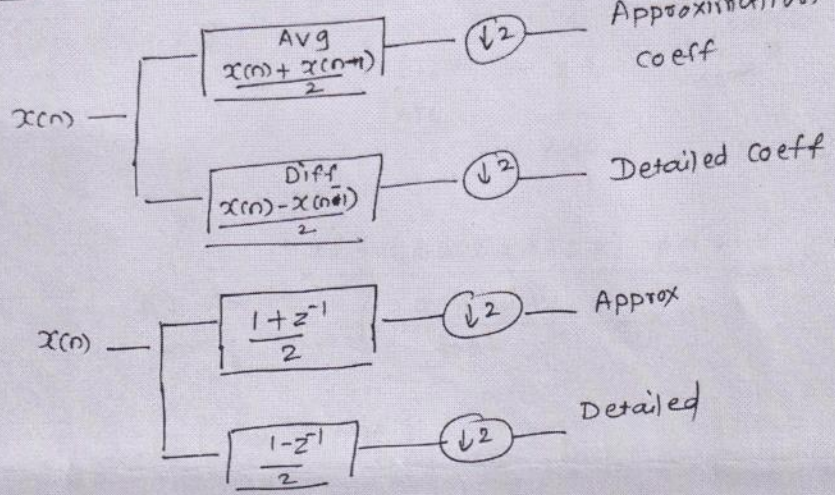
No. of freq ~~beans~~ bins = $\frac{\text{frame size}}{2} + 1$

$= \frac{1000}{2} + 1 = 501$ [2 M]

No. of frames = $\frac{\text{Samples} - \text{frame size}}{\text{hop size}} + 1$

$= \frac{10000 - 1000}{500} + 1 = 19$ [2 M]

b) Analysis Filter Bank



[2 M]

Seq $x(n) = \{4, 7, 10, 16, 14, 11, 3, -1\}$

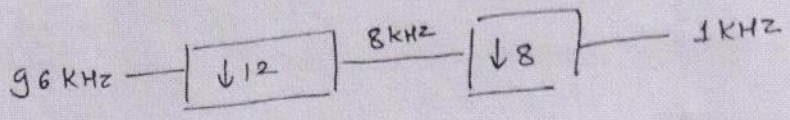
Avg : $\{\frac{11}{2} \quad \frac{17}{2} \quad \frac{26}{2} \quad \frac{30}{2} \quad \frac{25}{2} \quad \frac{14}{2} \quad \frac{2}{2}\}$

Diff $\{-\frac{3}{2} \quad -\frac{3}{2} \quad -3 \quad -1 \quad \frac{3}{2} \quad 4 \quad 2\}$ [2 M]

Avg — ↓2 — $\{\frac{11}{2}, 13, \frac{25}{2}, 1\}$

Diff — ↓2 — $\{-3/2 \quad -3 \quad 3/2 \quad 2\}$ [2M]

b)



$\delta p = \frac{0.01}{2} = 0.005$ For each stage

$\delta s = 0.001$

$F_{pass} = 450$

$F_{stop1} = 8000 - \frac{96000}{2 \times 96}$

$= 7500$

$\Delta = \frac{7500 - 450}{96000}$ [3 M]

$N_1 \approx \frac{-10 \log (0.005 \times 0.001) - 13}{14.6 \times \left(\frac{7500 - 450}{96000}\right)} \approx 38$

Stage 2 :

$F_{stop2} = 1K - \frac{9600}{2 \times 96}$ [3 M]

$= 500$

$N_2 \approx \frac{-10 \log (0.005 \times 0.01) - 13}{14.6 \times \left(\frac{500 - 450}{7500}\right)}$

≈ 417