(a) $\int_{0}^{1} h_{1} \int_{0}^{2} = \{2.1.2\} = 2\{[n] + \{[n-1] + 2\}[n-2]$

it is a GLP filter. A(w) = 400 w +1 , K=1, B=0

it is a linear phase filter

(b) $fhn \int_{n=0}^{2} = f - 1/3$, $1^{4} = -8En + 36En - 1 + 36En - 2$

H(w) = -[+3
$$e^{-j^{2}}$$
+ $e^{-j^{2}}$ +3]
= $e^{-j^{2}}$ (- $e^{j^{2}}$ + $e^{-j^{2}}$ +3)
= $(3+2)$ 5inw) $e^{-j^{2}}$

it is not a GLP filter

(c) $f(n) \Big|_{n=0}^{2} = \{1, 0, -1\} = f[n] - f[n-2]$

$$H(w) = 1 - e^{-\lambda j^{2} w} = e^{-j^{2} w} (e^{jw} - e^{-jw})$$
$$= \lambda j + 5 w \cdot e^{-j^{2} w}$$
$$= 25 w \cdot e^{-j^{2} w + \frac{\pi}{2}}$$

It is a GLP filter, A(w) = 2 sinw, a= 1, B= =

it is not a linear phase filter.

H(w) =
$$1 + e^{-j^2 w} - e^{-j^2 2w} - e^{-j^2 3w} = e^{-j^2 \frac{j}{2}w} L e^{j - \frac{j}{2}w} + e^{j^2 \frac{j}{2}w} - e^{-j^2 \frac{j}{2}w}$$

$$= 2j \left[Sin(\frac{j}{2}w) + Sin(\frac{j}{2}w) \right] e^{-j^2 \frac{j}{2}w} + \frac{\pi}{2}$$

$$= 2 \left[Sin(\frac{j}{2}w) + Sin(\frac{j}{2}w) \right] e^{-j^2 \frac{j}{2}w + \frac{\pi}{2}}$$

it is a GLP filter, Alw) = 2 [sin(w) + sin(w)], &= 3, p= 4

it is not a linear phase filter.

(e) fhn) = = {2,1,1,2} = 2f[n] +f[n-1]+f[n-2]+2f[n-3]

$$\begin{split} H(w) &= 2 + e^{-j^{2}w} + e^{-j^{2}2w} + 2 e^{-j^{2}4w} \\ &= e^{-j^{2}\frac{1}{2}w} \left[2 \left(e^{j^{2}\frac{1}{2}w} + e^{-j^{2}\frac{1}{2}w} \right) + e^{j^{2}\frac{1}{2}w} + e^{-j^{2}\frac{1}{2}w} \right] \\ &= \left[4 \left(\log(\frac{1}{2}w) + 2 \left(\ln(\frac{1}{2}w) \right) \right] e^{-j^{\frac{1}{2}w}} \end{split}$$

it is a GLP filter, A(w) = 4 Gs(1 w) + 2 Gs(1 w), d = 3 x, B=0

it is a linear phase filter

[2] length: M+1, lowpass. GLP FIR fitter, cut-off freq. $\frac{\pi}{3}$ $L[n] = g[n] \cdot w[n], g[n] = d[n-a] = \frac{\sin(w(a-n))}{\pi(n-a)}, a^{\frac{m+1}{2}} = \frac{m}{2}, w_{c} = \frac{\pi}{2}$ $\Rightarrow L[n] = \frac{\sin(\frac{\pi}{3}(n-\frac{m}{2}))}{\pi(n-\frac{m}{2})} \cdot w[n]$

(a) testangular window: $fh \in \Pi \subseteq M$ = $\frac{\sin(\frac{\pi}{3}(n-\frac{n}{2}))}{\pi(n-\frac{n}{2})}$

(b) hamming window, the East $\frac{M}{n} = \frac{5n(\frac{N}{2}(n-\frac{M}{2}))}{\pi(n-\frac{M}{2})} \cdot \left[0.51 - 0.46 \cos(\frac{2\pi M}{N-1})\right]$

(c) rectangular window, narrowest transition band, weakest stopband attenuation hamming window, widest transition band, strongest stopband attenuation.

[3]

- (a) the ideal characteristic should have a cutoff frequency at Wp, with possbond ripple as small as possible (like 0.1dB) and the stopband should contain (-T.-WSJVEWS, T.), with stopband attenuation about -100dB (10⁻⁵)
- (b) no: for a strpband attenuation 10th, that is -80cls, thus from the figure of window method we tought in class, the best is harming window with stopband attenuation around -69cls.

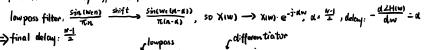
- (a) the CTFT of the derivative: Yc(1) = j 12 Xc(1)
- (b) Mc(t), Mc(t) Ts = MEAJ YEAJ $X_d(\omega) = \frac{1}{T_s} \stackrel{d}{\stackrel{d}{=}} \chi_a(\frac{\omega - 2n\pi}{T_s})$

$$Yd(w) = \frac{jw}{T_s^2} \sum_{-\infty}^{\infty} Xa(\frac{w-2\pi\pi}{T_s})$$

D(w)= To ,-wcewewe, obviously, Yalw)= D(w). Xalw)

(C) for method (1): first using type I filter, then using type III filter.

for method (2): using type III filter



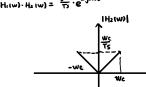
 \Rightarrow final delay: $\frac{N-1}{2}$

me thad (1):



H2(W)= jw F5

ideal frequency response HIW). HILW = e-jaw



method (2):

