1. \( h[n] = T_h(t=nT) = (0.2) 10 e^{-10(0.2n)} u(0.2n) = 2 e^{-2n} u[n] \).

2. \( S = \frac{2}{T} \tan \left( \frac{\omega}{2} \right) \rightarrow 1 = \tan \left( \frac{\omega}{2} \right) \rightarrow \omega = \pi/2 \) (not \( \pi/4 \)).

3. \( H_a(s) = s \) and \( s = \frac{2}{T} \frac{z-1}{z+1} \rightarrow H(z) = \frac{z-1}{z+1} - \frac{Y(z)}{X(z)} \rightarrow y[n] + y[n-1] = x[n] - x[n-1] \).

4. \( H(z) = \frac{10(z+1)}{10z+10(z+1)} = \frac{1}{2} (1 + z^{-1}) \). Average 2 most recent.

5. Bilinear transform maps Re\( [s] < 0 \rightarrow |z| < 1 \), so stable & causal → stable & causal.

6. \( h[n] = \{a, b, a\} \rightarrow H(e^{j\omega}) = ae^{j\omega} + b + ae^{-j\omega} = b + 2a \cos(\omega). \) Solve these equations:

- \( \omega = 0: 1 = b + 2a \).
- \( \omega = \pi: 0 = b - 2a. \) \( \omega = \frac{\pi}{2}: \frac{1}{2} = b + 0a \rightarrow a = \frac{1}{4}, b = \frac{1}{2} \rightarrow h[n] = \{\frac{1}{4}, \frac{1}{2}, \frac{1}{4}\} \).

7. \( h_{\text{IDEAL}}[n] = \frac{\sin(\pi n)}{\pi n} \rightarrow h[n] = w[n] h_{\text{IDEAL}}[n] = \frac{\sin(\pi n)}{\pi n} \), \( |n| \leq 1 = \{\frac{1}{\pi}, \frac{1}{2}, \frac{1}{\pi}\} \).

8. D. Could have used \texttt{fir1} for #8 and \texttt{fir2} for #7 (with different arguments).

9. D. \( a + b + 0 - b - a = 0 \) and \( a(-1)^2 + b(-1) + 0 - b(-1) - a(-1)^2 = 0. \)

10. B. A blurs the points; C makes the points only more prominent!

11. A. (b) doesn’t help; (c) makes noise worse since it enhances high frequencies.

12. E. (a) blurs image features; both (b) and (c) can help.

13. A. Only A does not reject DC and emphasize high frequencies.

14. C. Increasing N does not help resolve peaks unless N was very small.

15. A. Does not reduce sidelobes, only width of main peak (see formula in notes).

16. E. Reduces resolution and convolves spectrum with window’s spectrum, smoothing.

17. C. Downsampling by 2 doubles frequency to 600 Hz, which is aliased down to 400 Hz. The reconstructer output is never more than half the sampling rate, so no 600 Hz.

18. B. Upsampling halves frequency, but also brings in the aliased version (350 Hz) of it.


20. A. Don’t even think about asking for partial credit!