1. **A.** h[n]=Th(t=nT)=(0.1)40cos(20(0.1n))u(0.1n)=4cos(2n)u[n].

2. **E.** s=$\frac{2}{0.1}\frac{z-1}{z+1} \rightarrow H(z)=\frac{40\cdot 20\frac{z-1}{z+1}}{(20\frac{z-1}{z+1})^2+400}\frac{(z+1)^2}{(z+1)^2}=\frac{800(z-1)(z+1)}{400(z-1)^2+400(z+1)^2}=\frac{z^2-1}{z^2+1}$.

3. **D.** $20=\Omega=\frac{2}{0.1}\tan(\frac{\omega}{2}) \rightarrow 1=\tan(\frac{\omega}{2}) \rightarrow \omega=\pi/2$ (not $\pi/4$).

4. **C.** Bilinear transform maps Re[s]$< 0 \rightarrow |z| < 1$, so stable&causal→stable&causal.

5. **B.** h[n]=$\{a, \underline{0}, -a\} \rightarrow H(e^{j\omega})$=2ajsin($\omega$). $H(e^{j0})=H(e^{j\pi})$=0 satisfied automatically. $H(e^{j\pi/2})$=j$\frac{\pi}{2}$=2aj1$\rightarrow a=\frac{\pi}{4}$ →h[n]=$\{\frac{\pi}{4}, 0, -\frac{\pi}{4}\}$.

6. **E.** $h_{IDEAL}[n]=\frac{(-1)^n}{n}$ →h[n]=w[n]$h_{IDEAL}[n]=\{1, 0, -1\}$.

7. **E.** 'Hilbert' designs an odd-symmetry filter without weight used in 'differentiator.'

8. **B.** $H_a(s)=\frac{1}{s}$ and s=$\frac{2}{2}\frac{z-1}{z+1} \rightarrow H(z)=\frac{z+1}{z-1}=\frac{Y(z)}{X(z)}$ →y[n]–y[n-1]=x[n]+x[n-1]

9. **C.** Downsampling by 2 doubles frequency to 400 Hz. $400 < \frac{1}{2}1000$ →no aliasing.

10. **B.** Upsampling halves frequency, but also brings in the aliased version (400 Hz) of it.

11. **F.** A and C reduce, not raise, frequency. B and D first yield 600 Hz which gets aliased. E first yields 100&400 Hz; latter becomes 1200 Hz which gets aliased down to 200 Hz.

12. **E.** Probably easiest to simply try all four frequencies. Analytically, need: $\pm\omega/3=2\pi-3\omega \rightarrow 2\pi = 2.667\omega \rightarrow \omega = 0.75\pi$ or $2\pi = 3.333\omega \rightarrow \omega = 0.6\pi$.

13. **A.** Increasing N doesn't help; a Hamming window actually hurts (see #16).

14. **E.** Increasing L makes it sharper, not smoother. Increasing N→finer sampling. A window convolves the spectrum with the window's spectrum, making it smoother.

15. **C.** Increasing L does not reduce sidelobes; increasing N just samples them more finely.

16. **D.** A window broadens the peaks; decreasing N doesn't hurt–peaks still outlined.

17. **B**. Bandpass. Rejects $0 < \omega < 0.2\pi$ and $0.8\pi < \omega < \pi$; passes $0.3\pi < \omega < 0.7\pi$

18. **B**. Bandpass. Rejects both $\omega = 0, \pi$ since $H(e^{j0})$=a+b+c+d+0-d-c-b-a=0 and $H(e^{jpi})$=a-b+c-d+0-(-d)+(-c)-(-b)+(-a)=0

19. **C**. h[i,j]=h[i]h[j] where h[n]=$\{-1, 2, -1\}$ and $H(e^{j\omega})$=2-2cos(ω) is highpass filter. Note that h[n]=[1,-2,1] is NOT a notch filter, despite its form (the "notch" is at DC!).

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

SCORES	100	95	90	85	80	< 80	Total	Mean	Median
#ugrad	6	12	12	10	4	3	47	88.9	90
#grad	1	2	0	1	1	0	5	91.0	95