1. Use the formulae $T=\frac{2\pi}{\omega}$ (continuous time) and $\frac{2\pi}{\omega}=\frac{N}{D}$ $\rightarrow$period=N (discrete time).

(a) $\frac{2\pi}{0.16\pi}=\frac{200}{16}=\boxed{12.5}$ (b) $\frac{200}{16}=\frac{25}{2}$ $\rightarrow$N=$\boxed{25}$ (c) no π $\rightarrow\boxed{\infty}$

(d) $\frac{2\pi}{0.16\pi}=\frac{25}{2}\rightarrow 25$. $\frac{2\pi}{0.15\pi}=\frac{40}{3}\rightarrow 40$. LCM[25,40]=$\boxed{200}$

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2. x[n]=x(t=n/1000); alias x[n] using $\cos((\pi+\omega_o)n+\theta)=\cos((\pi-\omega_o)n-\theta)$.

(a) x[n]=$\cos(2\pi\frac{30}{100}n)+\cos(2\pi\frac{70}{100}n+\pi)=\cos(0.6\pi n)+\cos(1.4\pi n+\pi)$. Alias the 2^{nd} term: $\cos(1.4\pi n+\pi)=\cos(0.6\pi n-\pi)=-\cos(0.6\pi n)$ $\rightarrow$output=0! (b): See below.

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3. x[n]=x(t=n/1000); alias x[n] using $\cos((\pi+\omega_o)n+\theta)=\cos((\pi-\omega_o)n-\theta)$.

(a) x[n]=$\sin(2\pi\frac{30}{100}n)+\sin(2\pi\frac{70}{100}n)=\sin(0.6\pi n)+\sin(1.4\pi n)$. Alias the 2^{nd} term: $\sin(1.4\pi n)=\cos(1.4\pi n-\frac{\pi}{2})=\cos(0.6\pi n+\frac{\pi}{2})=-\sin(0.6\pi n)$ $\rightarrow$ output=0! (b): See below.

4a. $3-4j=\boxed{5e^{-j0.927}}$ (4b) $12+j5=\boxed{13e^{j0.395}}$

4c. $[(3-4j)+(12-5j)]^2=(15-9j)^2=225-81-2(j15)9=144-270j=\boxed{306e^{-j1.081}}$

4d. $\frac{3-4j}{12+5j}=\frac{5e^{-j0.927}}{13e^{j0.395}}=\frac{5}{13}e^{j(-.927-.395)}=\boxed{0.385e^{-j1.322}}$

OR: $\frac{3-4j}{12+5j}\frac{12-5j}{12-5j}=\frac{(36-20)-j(48+15)}{5^2+12^2}=.0947-.373j=0.385e^{-j1.322}$ (ugh).

5a. $4e^{jt}+4e^{-jt}=8\cos(t)$. (5b) $-je^{j2t}+je^{-j2t}=e^{-j\frac{\pi}{2}}e^{j2t}+e^{j\frac{\pi}{2}}e^{-j2t}=2\cos(2t-\frac{\pi}{2})=\boxed{2\sin(2t)}$

5c. $je^{j(3t+1)}-je^{-j(3t+1)}=e^{j(\frac{\pi}{2}+1)}e^{j3t}+e^{-j(\frac{\pi}{2}+1)}e^{-j3t}=2\cos(3t+\frac{\pi}{2}+1)=\boxed{-2\sin(3t+1)}$

5d. $(3+j4)e^{j6t}+(3-j4)e^{-j6t}=5e^{j.927}e^{j6t}+5e^{-j.927}e^{-j6t}=\boxed{10\cos(6t+.927)}$

6a. `X` is voice: "Matlab–Breakfast of Champions." Spectrum is bandlimited to 8 kHz.

6b. `Y` is the same voice speeded up by a factor of two. Spectrum is now aliased slightly.

6c. `Z` slowed down has a slight lisp–this is aliasing. Spectrum is now very aliased!
3 plots of spectra produced from Matlab code given in the problem set are below.
Note the high frequency components are different in each plot, due to aliasing.

(2b:) Upper left spectrum (cosines). **(3b:)** Lower left spectrum (sines; mult. by j).