4.2-16 Consider a signal $x(t) = 10\cos(2000\pi t) + \sqrt{2}\sin(3000\pi t) + 2\cos(5000\pi t + \frac{\pi}{4})$.

(a) Assuming that $x(t)$ is sampled at a rate of 4000 Hz, find the resulting sampled signal $x[n]$, expressed in terms of apparent frequencies. Does this sampling rate cause any aliasing? Explain.

$$f_1 = 1000Hz, f_2 = 1500Hz, f_3 = 2500Hz$$

$$f_a = \langle f_0 + \frac{F_S}{2} \rangle_{F_S} - \frac{F_S}{2}$$

$$f_{1\ apparent} = 3000\ mod\ 4000 - 2000 = 1000Hz$$

$$f_{2\ apparent} = 3500\ mod\ 4000 - 2000 = 1500Hz$$

$$f_{3\ apparent} = 4500\ mod\ 4000 - 2000 = -1500Hz$$

We can see that the apparent frequencies for f1 and f2 components are the same as their actual frequencies. But for f3 the apparent frequency is different than the actual frequency – because the sampling frequency is not meeting the Nyquist criteria of being twice the frequency of the largest frequency component of the signal.

(b) Determine the maximum sampling interval T that can be used to sample the signal in part (a) without aliasing.

The maximum sampling interval T will be the inverse of the minimum sampling frequency. This minimum F_S should follow Nyquist's criteria of being at least twice the frequency of the largest frequency component. So, this is 5000Hz