Chapter # 8 – Signal Processing

8.1 Sampling - Solutions

Consult NCEES® FE Reference Handbook – Pages 225 and 376 for reference

8.1 a) CORRECT ANSWER - A

According to Nyquist Theorem, signal needs to be sampled at or above Nyquist rate for perfect reconstruction.

8.1 b) CORRECT ANSWER: 2000 Hz

The given signal is a summation of two $sinc$ functions $sinc(1000\pi t)$ and $sinc(2000\pi t)$.

$sinc(2000\pi t) = sinc[2\pi(1000)t]$ carries the highest frequency component.

According to Nyquist Theory, perfect reconstruction requires sampling rate to be ≥ 2 x highest frequency.

Therefore, required sampling rate shall be $\geq 2 \times 1000\,Hz = 2000\,Hz.$

8.1 c) CORRECT ANSWER - C

According to the problem statement $x(t) = \cos(2\pi(1500)t + \theta).$

Signal frequency $= 1500\,Hz$ and sampling frequency $= 2000\,Hz.$

Aliasing will occur because sampling frequency $< 2 \times$ signal frequency.

8.1 d) CORRECT ANSWER - D

Alias frequency = |signal frequency – n x sampling frequency|

'n' is an integer that brings n x sampling frequency closest to signal frequency. In our case, n = 1 as shown below.

Alias frequency = |1500Hz – 1 x 2000Hz|= |– 500Hz|= 500 Hz.

Reconstructed signal frequency will be 500Hz with a negative phase angle (due to negative sign inside mod operator) as shown below.

$x'(t) = \cos(2\pi(500)t - \theta)$

$x'(t) = \cos(1000\pi t - \theta)$

8.1 e) CORRECT ANSWER - D

According to the problem statement $x(t) = \cos(2\pi(250)t + \theta).$

Signal frequency $= 250\,Hz$ and sampling frequency $= 500\,Hz.$

Aliasing will not occur because sampling frequency $= 2 \times 250\,Hz = 500\,Hz.$