**Note: For this assignment, your Handwritten, hard-copy solution is due on or before September 29th, 2012.**

**Question No. 1**

Given an analog signal:

$$x\left(t\right)=5\cos(\left(2π ∙1500t\right), for t \geq 0,)$$

sampled at a rate of 8,000 Hz,

1. sketch the spectrum of the original signal
2. sketch the spectrum of the sampled signal from 0 kHz to 20 kHz.

**Question No. 2**

Given an analog signal:

$$x\left(t\right)=5\cos(\left(2π ∙2500t\right)+ 2\cos(\left(2π ∙3200t\right)), for t \geq 0,)$$

sampled at a rate of 8,000 Hz,

1. sketch the spectrum of the sampled signal up to 20 kHz;
2. sketch the recovered analog signal spectrum if an ideal lowpass filter with a cutoff frequency of 4 kHz is used to filter the sampled signal in order to recover the original signal.

**Question No. 3**

Given an analog signal:

$$x\left(t\right)=5\cos(\left(2π ∙2500t\right)+ 2\cos(\left(2π ∙4500t\right)), for t \geq 0,)$$

sampled at a rate of 8,000 Hz,

1. sketch the spectrum of the sampled signal up to 20 kHz;
2. sketch the recovered analog signal spectrum if an ideal lowpass filter with a cutoff frequency of 4 kHz is used to filter the sampled signal in order to recover the original signal;
3. determine the frequency / frequencies of aliasing noise.

**Question No. 4**

Given an analog signal:

$$x\left(t\right)=10\cos(\left(2π ∙5500t\right)+ 5\sin(\left(2π ∙7500t\right)), for t \geq 0,)$$

sampled at a rate of 8,000 Hz,

1. sketch the spectrum of the sampled signal up to 20 kHz;
2. sketch the recovered analog signal spectrum if an ideal lowpass filter with a cutoff frequency of 4 kHz is used to filter the sampled signal in order to recover the original signal;
3. determine the frequency / frequencies of aliasing noise.

**Question No. 5**

Consider the analog signal:

$$x\left(t\right)=3\cos(\left(100πt\right))$$

1. Determine the minimum sampling rate required to avoid aliasing.
2. Suppose that the signal is sampled at the rate of 200 Hz. What is the discrete-time signal obtained after sampling?
3. Suppose that the signal is sampled at the rate of $f\_{s}=75 Hz$. What is the discrete-time signal obtained after sampling?
4. What is the frequency $0<F<f\_{s}/2$ of a sinusoid signal that yields samples identical to those obtained in part (c)?

**Question No. 6**

Given the analog signal:

$$x\left(t\right)=3\cos(\left(50πt\right)+ 10\sin(\left(300πt\right)-\cos(\left(100πt\right))), for t \geq 0,)$$

What is the Nyquist rate for this signal?

**Question No. 7**

Consider the analog signal:

$$x\left(t\right)=3\cos(\left(2000πt\right)+ 5\sin(\left(6000πt\right)+10\cos(\left(12000πt\right))), for t \geq 0,)$$

1. What is the Nyquist rate for this signal?
2. Assume now that we sample this signal using a sampling rate of 5000 samples/s. What is the discrete-time signal obtained after sampling?

**Question No. 9**

If the analog signal to be quantized is a sinusoidal waveform, that is,

$$x\left(t\right)=9.5\sin(\left(2000×πt\right))$$

and if the bipolar quantizer uses 6 bits, determine

1. number of quantization levels;
2. quantization step size or resolution,$ Δ$, assuming that the signal range is from $-10$ to $10$ volts;
3. the signal power to quantization power ration.

**Question No. 10**

An digital communication link carries binary-coded words representing samples of an input signal

$$x\_{a}\left(t\right)=2\cos(\left(600πt\right)+2\cos(\left(1800πt\right)))$$

The link is operated at 10,000 bits/s and each input sample is quantized into 1024 different voltage levels.

1. What are the sampling frequency and the folding frequency?
2. What is the Nyquist rate for the signal $x\_{a}\left(t\right)$?
3. What are the frequencies in the resulting discrete-time signal $x\left[n\right]$?
4. What is the resolution $Δ$?