CARLETON UNIVERSITY
Department of Systems and Computer Engineering

SYSC 4600 **Digital Communications** **Fall 2016**

Assignment 1 – 130 points H. Yanikomeroglu

Posted on: **Wednesday, 07 September 2016**
Due on : **Will not be collected (for studying purposes only)**

Q1. (10 pts) There is a linear time-invariant (LTI) channel with impulse response *h(t)*. The input and output of the channel are denoted by *x(t)* and *y(t)*, respectively. The corresponding Fourier Transforms are *H(f)*, *X(f)*, and *Y(f)*, respectively. Write the output in terms of the input and channel

- in time domain,
- in frequency domain.

Q2. (10 pts) Sketch the power spectral density (PSD) of white noise.

Q3. (10 pts) Sketch the PDF (probability density function) and CDF (cumulative distribution function) curves for a Gaussian random variable.

Q4. (10 pts) If SNR = 20 in the linear domain, what is SNR in dB?

Q5. (10 pts) In a statistical experiment, the five possible outcomes for the random variable X are as follows: {1, 4, -3, -2, 5}. All the outcomes are equally-likely with probability 1/5. Find the mean and variance of X.

Q6. (10 pts) Sketch $\cos(2\pi f_c t + \pi/4)$.

Q7. (20 pts) X is uniform random variable taking values in the range [0, 4].

Draw the PDF of X. # Draw the CDF of X.
Find the variance of X. # Find Prob(2<X<3). # Find Prob(X=3).

Q8. (20 pts) Consider a wireless channel modelled as an LTI (linear, time-invariant) system with an impulse response $h(t) = a\delta(t) + a\delta(t-T/2)$, where *a* is a constant. Let us assume that *x(t)* is the transmitted signal representing one single bit; it is a rectangular function with amplitude 1 and duration [0, *T*]. Find the received signal $y(t)$.

Q9. (10 pts) We have two signals *x(t)* and *y(t)*; the former one is a baseband signal and the latter a bandpass signal. The Fourier transforms of these signals, *X(f)* and *Y(f)*, are given as follows:

$$X(f) = \begin{cases} \alpha, & -3MHz \le f \le 3MHz \\ 0, & elsewhere \end{cases} \quad \text{and} \quad Y(f) = \begin{cases} \beta, & -200MHz \le f \le -150MHz \\ \beta, & 150MHz \le f \le 200MHz \\ 0, & elsewhere \end{cases}.$$

Find the bandwidth of these two signals.

Q10. (20 pts) The probability of error (bit error rate) versus SNR curve for BPSK (binary phase shift keying) is given below. If 1 million bits are received at 8 dB SNR, on average how many of them will be detected erroneously?