CARLETON UNIVERSITY

Department of Systems and Computer Engineering

SYSC 4700 **Telecommunications Engineering** **Winter 2018**

Professor Halim Yanikomeroglu

Assignment 1 [120 pts]

Posting date: **January, 24 January 2018**
Due date: **2:00 pm, Friday, 02 February 2018**
Where to submit: **Assignment box, Mackenzie 4th floor, 4th wing**
Late submissions: **No late submissions (please)**

Q1 [25 pts] – Pulse Code Modulation based Analog-to-Digital Conversion

Consider a high-quality analog-to-digital converter (ADC) for voice signals with the following specifications:

- The ADC captures the detail in the voice signal up to 18 KHz.
- 4096 levels are used for quantization.

Next, consider a time-division multiplexing scheme (TDM) which combines the digital output from 11 users whose analog data is digitized through the above described ADC scheme. A TDM frame consists of samples from 11 users plus two bits for synchronization purposes.

(a) Find the line speed (in bits/sec) to carry this TDM traffic.

(b) Assuming that M-ary modulation is used (i.e., there are M levels per each symbol), find the minimum M if the line has 4 MHz of bandwidth.

Q2 [25 pts] – Short Questions

a) What is the biggest (i.e., most profound) difference between 1G-4G and 5G?

b) State the data rate for digital voice communications commonly used in the below cases.

- Wireless cellular networks
- Wired telephony (PCM)
- Audio CD

Q3 [15 pts] – Power Spectral Density

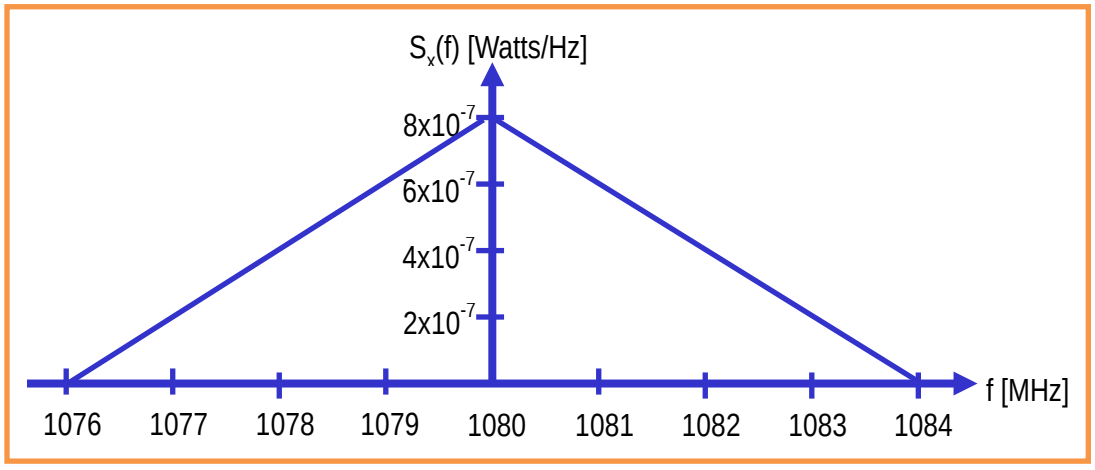
The PSD (power spectral density), $S_X(f)$, of a signal $X(t)$ is given as

$$S_X(f) = \begin{cases} \beta, & -950MHz \le f \le -900MHz \\ \beta, & 900MHz \le f \le 950MHz \\ 0, & elsewhere \end{cases}.$$

- Find the bandwidth of $X(t)$.
- Find the total power of $X(t)$.

Q4 [55 pts] – Power Spectral Density

The double-sided power spectral density, $S_x(f)$, for a digital signalling scheme is given below. PSD is symmetric with respect to the $f = 0$ Hz vertical axis; the left part is not shown.



a) Find the total power of this signalling scheme.

b) How much power does this signalling scheme has between 1082 MHz and 1083 MHz?

c) How much power does this signalling scheme has at 1083 MHz?

d) Find the absolute bandwidth of this signalling scheme.

e) $BW_{90\%}$ (90%-bandwidth) is defined as the frequency region in which 90% of the total power is confined to. Find $BW_{90\%}$ for this signalling scheme.