Sabancı University
Faculty of Engineering and Natural Sciences

EE 314 Digital Communications Spring 2019

Assoc. Prof. Mehmet Keskinöz

HOMEWORK #2

Assigned: Mar. 23, 2021
Due : Mar. 31, 2019, 23:55

- ***Remarks: Please keep your answers clear and concise and show all the mathematical derivations that you perform. Each student should write up the solutions entirely on their own. You should list your name and ID on your write-up. If you do not type your solutions in a computer, be sure that your hand-writing is legible, your scan is high-quality and your name and ID are clearly written on your submitted document.***
- ***Your solutions should be scanned as a single pdf file (we wont accept other format such as jpeg or multiple files). You should name your pdf file as first_name_lastname_HW_number (e.g., Mehmet_Keskinoz_HW_1)***
- ***If you have a MATLAB problem, you should also be required to submit your .m file (name .m file as first_name_lastname_HW_number and write your name and ID as a commented header in the .m file) .***
- ***if you don't have a MATLAB related problem in your homework, just upload your solutions as a single pdf file . Otherwise, you should zip your .m file together with your pdf file (name the zip file as as first_name_lastname_HW_number) and upload your single zip file to SUCOURSE.***
- ***Note that you can only get help from your TAs on MATLAB related questions during their office hours.***
- ***If you want to get feedbacks about your homework, you should also submit hand-written (or hard-copy) of your solutions.***
- ***Late submission will not be accepted***

(1) Find the average normalized power in the waveform $x(t) = 2 + 5\sin(6\pi t) + 15\cos(12\pi t)$

i) using time averaging
ii) using summation of spectral coefficients.

(2) Let $y(t) = x^2(t)$ and $x(t) = 400\,\text{sinc}(400t)$. Determine the followings:

i. Is $y(t)$ an energy or power type signal? Why?
ii. Determine the spectral density of $y(t)$?
iii. Determine bandwidth of $y(t)$.

(3)

For a lowpass signal with a bandwidth of 6000 Hz, what is the minimum sampling frequency for perfect reconstruction of the signal? What is the minimum required sampling frequency if a guard band of 2000 Hz is required? What is the minimum required sampling frequency and the value of K for perfect reconstruction if the reconstruction filter has the following frequency response

$$H(f) = \begin{cases} K, & |f| < 7000 \\ K - K\frac{|f| - 7000}{3000}, & 7000 < |f| < 10000 \\ 0, & \text{otherwise} \end{cases}$$

(4) An analog signal with maximum frequency of 5 kHz is to be transmitted through an *M*-ary PAM system with *M* being 16. To satisfy transmission requirements, quantization errors must be between -0.5 % and 0.5% of the peak-to-peak analog signal.

- **(a)** What is the minimum number of quantization bits in a sample?
- **(b)** What is the minimum sampling rate and corresponding bit transmission rate ?
- **(c)** What is the symbol-rate?
- **(d)** Determine the minimum transmission bandwidth

(5) Design an eight level non-uniform quantizer which is derived from a μ -law compressor with $\mu = 255$. Assume that quantizer handles input signals that swings from -2 Volts to 2 Volts.