**Electrical and Computer Engineering Department**

**University of Puerto Rico at Mayagüez**



**COMMUNICATION THEORY I**

**MATLAB CLASSWORK 03**

**DSB-SC Communications System**

**and**

**Speech & DTMF Signal Transmissions**

For

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<Date>

**HW03 – Due: Friday, Oct. 29, before 11:50 PM**

**Speech & DTMF Signal Transmissions**

The objective of this homework is to model a double sideband suppressed carrier ([**DSB-SC**](http://en.wikipedia.org/wiki/Double-sideband_suppressed-carrier_transmission)) communications system for the transmission and reception of [**speech signals**](http://cnx.org/contents/46c9564f-32cd-4f98-b487-50e7318032f2@30)as well as voice-like ([**DTMF**](https://ptolemy.berkeley.edu/eecs20/week2/dtmf.html)) signals in an [**underwater medium**](http://www.sciencedirect.com/science/article/pii/S2092678216304502).

The [**maximum frequency content**](https://inst.eecs.berkeley.edu/~ee20/sp97/laboratories/06_QuantFilt/html/node3.html)of all transmitted signals is assumed to be equal to and the “[**one-sided**](https://en.wikipedia.org/wiki/Bandwidth_(signal_processing))” [**channel bandwidth**](https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php) is said to be equal to . For the proper reception of the transmitted signal, a receiver must be designed to recover such signal: (see [***Fig. 3***](file:///G:\inel4301\Information\Fig3.pdf)).

The channel itself is modeled as a composition of two basic systems, an [**ideal**](https://www.sciencedirect.com/topics/engineering/ideal-filter), [**linear phase**](http://www.dspguru.com/dsp/faqs/fir/properties), [**low-pass filter**](https://en.wikipedia.org/wiki/Low-pass_filter), with [***cut-off frequency***](https://en.wikipedia.org/wiki/Low-pass_filter) , and a signal [**summing system**](http://www.mathworks.com/help/comm/ref/awgn.html), , where the channel [**underwater noise signa**l](http://en.wikipedia.org/wiki/Underwater_acoustics#Ambient_noise), , is added to the output of the linear phase filter . This DSB-SC communications channel is given the name . Thus, it is given by cascading and (see [***Fig. 2***](file:///G:\inel4301\Information\Fig2.pdf)).

The sampling frequency of the [**DSB-SC communications**](https://www.tutorialspoint.com/analog_communication/analog_communication_dsbsc_modulation.htm) system must be set to more than twice the maximum frequency([**Nyquist-Shannon sampling theorem**](http://en.wikipedia.org/wiki/Nyquist%E2%80%93Shannon_sampling_theorem)) content of the output of the demodulator at the receiver side. That is, , where is the carrier frequency of the modulator (demodulator) and must be .

The input signal to the modulator is the sum of a “**wanted**” speech signal *s*(*t*) and an “**unwanted**” [**interference signal**](https://dosits.org/tutorials/science/) *g*(*t*). After the demodulator, an ideal, linear phase, low-pass filter, is used, with cut-off frequency , to recover “**wanted**” [**speech or voice signal**](https://blog.accusonus.com/pro-audio-production/human-voice-frequency-range/) *s*(*t*) (see [***Fig. 1***](file:///G:\inel4301\Information\Fig1.pdf)).

**Tasks to Perform**

**Task 01.- (10 points):** Proceed to modify the given MATLAB m-script located in the course main webpage under the heading [**DSBSC\_Draft**](file:///G:\inel4301\Information\dr_com_dsbsc.m) in the by adding instructions in order to plot the modulating signal in the time-domain. For this task, you must also load the speech signal “**[Star\_Story](G:\\inel4301\\Information\\star_story.wav)**.” Rename this file hw03gpzzt01.m where zz is group number.

**Task 02.- (10 points):** Proceed to modify the given MATLAB m-script located in the course main webpage under the heading [**DSBSC\_Draft**](file:///G:\inel4301\Information\dr_com_dsbsc.m) in the by adding instructions in order to plot the magnitude of the spectrum of the modulating signal in the time-domain. For this task, you must also load the speech signal “**[Star\_Story](G:\\inel4301\\Information\\star_story.wav)**” and rename this file hw03gpzzt02.m where zz is group number.

**Task 03.- (10 points):** Proceed to modify the given MATLAB m-script located in the course main webpage under the heading [**DSBSC\_Draft**](file:///G:\inel4301\Information\dr_com_dsbsc.m) in the by adding instructions in order to plot the interfering signal in the time-domain. For this task, you must also load the speech signal “**[Star\_Story](G:\\inel4301\\Information\\star_story.wav)**” and rename this file hw03gpzzt03.m where zz is group number.

**Task 04.- (10 points):** Proceed to modify the given MATLAB m-script located in the course main webpage under the heading [**DSBSC\_Draft**](file:///G:\inel4301\Information\dr_com_dsbsc.m) in the by adding instructions in order to plot the magnitude of the spectrum of the interfering signal in the time-domain. You must also load the speech signal “**[Star\_Story](G:\\inel4301\\Information\\star_story.wav)**” and rename this file hw03gpzzt04.m where zz is group number.

**Tasks 05 to 08 (15 points each):** Proceed to repeat **Tasks** **01** to **04** by changing the input signal to a [**DTMF** **voice-like**](https://www.audiocheck.net/audiocheck_dtmf.php) signal. Rename, from hw03gpzzt05.m to hw03gpzzt08.m, the resulting m-scripts, accordingly. Use hw03gpzzt05.wav to hw03gpzzt08.wav to name your [**DTMF**](https://www.youtube.com/watch?v=6QGgbiOay3I) files in **.wav** format.

**REMARKS:**

**A.-** This homework does not require a written report. All that is required is for each group to send a **.zip** folder with the requested eight (8) m-script files, with the required TAT document in **.PDF** format, as well as this document, both, in **.DOCX** and **.PDF** formats. A total of **11 documents**, nothing else, should be sent inside the **.zip** folder.

**B.-** Name of **.zip** folder and the name of the **e-mail subject**:

**INEL4301\_MCW03\_SXXX\_GPYY**

**E-mail to:** [**domingo.rodriguez1@upr.edu**](mailto:domingo.rodriguez1@upr.edu)

**STANDARD TABLE FOR DEMERITS**

|  |  |
| --- | --- |
| **01.- Script file does NOT execute well** | **-05 pts.** |
| **02.- Correct script file NOT included** | **-05 pts.** |
| **03.- Task assignment table NOT included** | **-05 pts.** |
| **04.-** [**Unzipped folder**](https://www.youtube.com/watch?v=Z1Uwmxdshqc) **does NOT have same name** | **-05 pts.** |
| **05.- Missing INEL4301\_MCW03\_SXXX\_GPYY.docx** | **-03 pts.** |
| **06.- Missing INEL4301\_MCW03\_SXXX\_GPYY.pdf** | **-03 pts.** |
| **07.- Missing class section number sxxx** | **-03 pts.** |
| **08.- Missing student’s group number gpyy** | **-03 pts.** |
| **09.- Missing script or program number pgzz** | **-03 pts.** |
| **10.- Missing or incorrect e-mail subject name** | **-03 pts.** |