EE 340 End-semester Examination

Name:
Roll no.:

Read the following instructions carefully before starting the exam.

1. *Fill in your name and roll number at the top of this question paper. You have to return this sheet to your TA after the exam.*
2. *You have 90 minutes to complete this exam.*
3. *You are not allowed access to any notes, labsheets, or older GNU Radio files during the exam.*
4. *Save important snapshots and your GNU Radio source files in a zip archive (the file name being your roll number).*
5. *You have to upload the above zip file on the moodle assignment by the name 'End-sem'* **within five minutes of the exam completion time**. *The system will not allow an upload after this deadline; students who do not make the upload will be awarded zero marks.*
6. *Access to the internet, except for downloading the two data files required for the exam, and for uploading your final results, is strictly prohibited.*

1. **[12 marks]** A message signal is transmitted using 8-PSK modulation with a symbol rate of 20 kSymbols/sec, using a carrier frequency of 200kHz. Pulse shaping is performed, at $\mathrm{sps} = 5$, using the raised cosine pulse using the following GNURadio command.

   ```
   firdes.root_raised_cosine(32, 32*input_sps, 1.0, 0.35, 1760)
   ```

   The transmitted (passband) signal $x(t)$ suffers multipath reflection, such that the received (passband) signal

   $$y(t) = x(t) + 0.4x(t - \tau_1) + 0.2x(t - \tau_2),$$

   where $\tau_1 = 40\mu s$, $\tau_2 = 50\mu s$. This received (**real** passband) signal $y(t)$, sampled at 500 kHz, is provided to you at the following link:
   `https://drive.google.com/open?id=1wOpNR2UiYdpWo5z1wQejTWiB0O5n5ZbV`

   (a) **[6 marks]** Recover the 8-PSK constellation. You are allowed to use all the built-in blocks used in your lab sessions for this.

   (b) **[6 marks]** Repeat the above, but without using built-in equalization blocks. In other words, you have to design the equalizer yourself. The filter design should be analytically sound; trial and error solutions will receive less credit.

   Useful information: Use the "File Source" block to read the data file into GNU Radio. Remember to set the output type to **real**, and to configure the block to repeat the data in a loop so that you have a continuous data stream to work with.

Describe your equalization filter design here:

Your response

For both parts, show your constellation output (using QT GUI Constellation Sink or WX GUI Scope Sink with XY Mode ON) to your TA and also save a snapshot in your submission archive.

TA comments

2. In this exercise, you have to demodulate two amplitude modulated music clip that have been modulated as follows. Denoting the message signals as $m_1(t)$ and $m_2(t)$, and the carrier frequency by f_c, the transmitted passband signal is

$$m_1(t)\cos(2\pi f_c t) + m_2(t)\sin(2\pi f_c t).$$

Your task is to recover both message signals (in this case, recover the audio for each music clip clearly). The transmitted passband signal, generated using $f_c = 100$ kHz and sampled at 1.6 MHz, is available at the following link:
`https://drive.google.com/open?id=1zVP9drw3heGbpdoisBMa7TIA5iBxkVma`

Important note: There will in general be a phase offset between the carrier signal you use for down conversion and the carrier we used for generating the transmitted signal. You have to account for this phase offset in your implementation.

Describe your methodology here:

Your response

TA comments