EE 340 End-semester Examination

Read the following instructions carefully before starting the exam.

1. *You must remain logged on to the MS Teams channel you have been assigned to, with your video running, until your exam is completed. You must also, in parallel, perform a screen recording on the PC you are using to take the exam (using GNU Radio); you will be required to submit this recording when we ask for it after the exam.*
2. *You have ninety minutes to complete this exam.*
3. *You are not allowed access to any notes, labsheets, or older GNU Radio files during the exam.*
4. *Access to the internet, except for participating in the exam video calls, downloading the exam data files, and for uploading your final results, is strictly prohibited.*
5. *Save important snapshots and your GNU Radio source files in a zip archive (the file name being your roll number). 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. *After uploading your results, you are to remain logged on to the call on Teams, until you are called upon one by one for your viva.* **Only after this viva is your exam considered complete.**

A text message signal is transmitted using *differential* QPSK modulation with a symbol rate of 25 kSymbols/sec, using a carrier frequency of 100 kHz. Pulse shaping is performed using the raised cosine pulse using the following GNURadio settings:

```
tx_taps: firdes.root_raised_cosine(nfilts,nfilts,1.0,excess_bw,ntaps)
```

```
nfilts =  32; excess_bw = 0.4; ntaps = 11*nfilts*sps; sps = 4
```

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

$$y(t) = x(t) + 0.6x(t - \tau_1) + 0.09x(t - \tau_2),$$

where $\tau_1 = 40\mu s$, $\tau_2 = 80\mu s$. This received (**real,** passband) signal $y(t)$, sampled at 500 kHz, is provided to you on as data1.dat

The encoding used for the differential QPSK modulation is as follows:

Information bits	Encoded phase change
00	0
01	$+\pi/2$
10	$+\pi$
11	$+3\pi/2$

Table 1: Encoding for differential QPSK

(a) **[10 marks]** Recover the QPSK constellation. You are allowed to use all the built-in blocks used in your lab sessions for this.

(b) **[10 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.

(c) **[10 marks]** Now, recover the transmitted message signal, which is a text file. For this step, use the equalizer designed in Part (b). Note that you have to perform the differential QPSK demodulation and write your output as a .txt file.

Useful information: Use the "File Source" block to read the data file into GNU Radio. Remember to set the output type to **Byte**, and to configure the block to repeat the data in a loop so that you have a continuous data stream to work with in Parts (a) and (b). In Part (c), you might want to avoid the looping, so that you don't have a 'growing' output file. Also, for Part (c), don't forget to use "Skip Head" to remove any 'junk bits' at the beginning of your output file.