

# EE 4140- Digital Communications July-November 2018

### **Computer Assignment Submission Instructions**

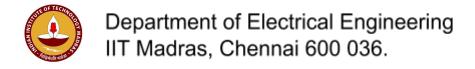
- Submit the assignment individually or as team of two students
- Please submit the following
  - Required plots
  - Include brief explanation of observations, as appropriate
- The submitted file should be in .pdf format

Use following naming convention for file

- Mention name and roll number of both team members
- o roll\_number\_assign#.pdf□
   o example:EE15Bxxx\_assign1.Pdf □
   o (Use roll number of one of the team members) □□
- Assignment submission via Moodle
  - o Instructions given by TAs □
  - Do not send via email
- Honour Code:
  - o Add this line to your assignment and an electronic signature
  - I certify that this assignment submission is my own work and not from obtained from any other source

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### Computer Assignment - 1 (Due date: August 19, 2018)

- **1.** Consider the passband signal  $u_p(t) = sinc(t) cos20\pi t$ , where the unit of time is in microseconds.
  - a) Use Matlab to plot the signal (plot over a large enough time interval so as to include "most" of the signal energy). Label the units on the time axis.

**Remark**: Since you will be plotting a discretized version, the sampling rate you should choose must be large enough that the carrier waveform looks reasonably smooth (e.g., a rate of at least 10 times the carrier frequency).

- b) Write a Matlab program to implement a simple downconverter as follows. Pass  $x(t) = 2u_p(t)cos20\pi t$  through a lowpass filter which consists of computing a sliding window average over a window of 1 microsecond. That is, the LPF output is given by  $y(t) = \int_{t-1}^{t} x(\tau) d\tau$ . Plot the output and comment on whether it is what you expect to see.
- **2.** The Square Root Raised Cosine (SRRC) pulse is commonly used in wireless communications. The expression of the impulse response is given below:

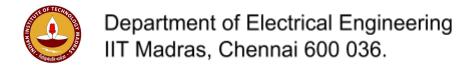
$$h(t) = \begin{cases} \frac{1 - \alpha + 4\frac{\alpha}{\pi}}{\pi}, & t = 0\\ \frac{\alpha}{\sqrt{2}} \left[ \left( 1 + \frac{2}{\pi} \right) \sin\left(\frac{\pi}{4\alpha}\right) + \left( 1 - \frac{2}{\pi} \right) \cos\left(\frac{\pi}{4\alpha}\right) \right], & t = \pm \frac{T}{4\alpha}\\ \frac{\sin\left[\pi \left( 1 - \alpha\right) \frac{t}{T}\right] + 4\alpha \frac{t}{T} \cos\left[\pi \left( 1 + \alpha\right) \frac{t}{T}\right]}{\pi \frac{t}{T} \left[ 1 - \left( 4\alpha \frac{t}{T}\right)^2 \right]}, & \text{for all other } t \end{cases}$$

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where  $\alpha$  is the roll-off factor. Plot the normalized frequency response  $20 \log \log H(e^{j\omega})$  vs  $\omega$  computed via DFT for the following values of roll-off factor :  $\alpha$  = 0.35, 0.7 and 1.0. Use 8X oversampling factor in the representation of the SRRC pulse and a truncation length of 10 symbols. Assume that the symbol rate is 25 K symbols/sec.

(Note: You should not use MATLAB built-in function for generating the SRC pulse)

#### 3. Verification of ISI-free property of RC pulse:

- a) Generate the SRRC as defined in question 2.
- b) Convolve the SRRC pulse with itself to get an RC pulse (SRRC \* SRRC).
- c) Take a random sequence of 20 bits ( $\pm$ 1). Apply RC pulse shaping to this data sequence.
- d) Select the samples the resultant waveform at symbol-spaced sampling points which correspond to the peak of the RC pulse.
- e) Write down the values of the samples.
- f) Observe that there is no ISI at the ideal sampling points.
- g) For this sequence, generate the eye diagram (to show the optimum sampling point).

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