Assignment 4

Communication Theory - 1 (EC5.203 - Spring 2021)

February 20, 2021

Deadline: 04/03/2021 - 11:55 PM

Submission Format:

- For analytical problems, write on A4 sheets and submit manually. For simulation code (if any) submit single .zip file with roll-number as filename containing .m files. Submit a report along with the simulation code explaning the obtained results and inferences.

Questions

1. Use small-error PLL analysis to show that a first-order loop $[H(s) = 1]$ cannot track an incoming signal whose instantaneous frequency is varying linearly with time $[\theta_i(t) = kt^2]$. This signal can be tracked within a constant phase if $H(s) = (s + a)/s$. It can be tracked with a zero-phase error if $H(s) = (s^2 + as + b)/s^2$

2. A dual band radio operates at 900 MHz and 1.8 GHz. The channel spacing in each band is 1 MHz. We wish to design a superheterodyne receiver with an IF of 250 MHz. The LO is built using a frequency synthesizer that is tunable from 1.9 GHz to 2.25 GHz., and frequency divider circuits if needed (assume that you can only implement frequency division by an integer).

   (a) How would you design a superhet receiver to receive a passband signal restricted to the band 1800 MHz - 1801 MHz? Specify the characteristics of the RF and IF filters, and how you would choose and synthesize the LO frequency.

   (b) Repeat (a) when the signal to received lies in the band 900 MHz - 901 MHz.

3. [MATLAB Simulation] A Sinusoidal message signal of frequency 100 Hz is modulated with a sinusoidal carrier of frequency 1 KHz with modulation index $k_f = 0.06$

   (a) Plot the message signal, carrier signal and the FM modulated signal.

   (b) Plot the outputs of each of the following blocks: PLL loop filter/integrator, VCO and phase detector.

   (c) Can you plot the original message signal and demodulated signal together on a single graph? What can you visualize from this plot?