ECE 642 - Assignment 4

Please provide all details of your calculations. Responses with no details will not be considered. When plotting either by hand or with MATLAB, please label all the axes with specific numerical values and units of measure. MATLAB may be used *only* when explicitly stated. Include your MATLAB code and plots.

1. (2 points) Given the signal $x(t) = u(t) - u(t-1)$, where $u(t)$ is the step function (i.e., $u(t) = 0$ for $t < 0$ and $u(t) = 1$ for $t \geq 0$), compute the Fourier transform of

$$y(t) = x(t + 1/2)\sin(500\pi t).$$

What is the phase of the Fourier transform at frequency $f = 250$ Hz?

2. (3 points) Two information signals, given by $a(t) = \cos(2\pi t)$ and $b(t) = 5\cos(2\pi t)$, are modulated on carrier at frequency $f_c = 10$ Hz in such a way that the in-phase component of the resulting passband signal is $a(t)$ and the quadrature component is $b(t)$.

a. Sketch the evolution of the complex baseband signal $x_z(t)$ in the complex plane (by hand, not using MATLAB) by explicitly marking the time instants t at which some of the values of $x_z(t)$ are taken.

b. Calculate and plot by hand the amplitude $x_A(t)$ and phase $x_P(t)$ of the complex baseband equivalent signal.

3. (3 points) We multiply the passband signal $x_c(t) = \sqrt{2}x_I(t)\cos(20\pi t) - \sqrt{2}x_Q(t)\sin(20\pi t)$, by $\cos(20\pi t + \pi/4)$, and we then perform a low-pass filter that removes all frequencies larger (in absolute value) than 1.5 Hz.

a. Calculate the output of the filter. Can this work as a downconverter?

b. Calculate the impulse response of the low-pass filter.

4. (2 points) For the passband signal $x_c(t) = \sqrt{2}\cos(2\pi t)\cos(20\pi t) - 5\sqrt{2}\cos(2\pi t)\sin(20\pi t)$:

a. Choose a suitable sampling period T_s.

b. Sketch the absolute value of the Fourier transform using MATLAB. Use different sizes of the input vector and compare your results.