Lab 3

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1 Exercises

1.1 Exercise 1

Solved with the following two code blocks:
x(t):

```
function x = x(t)
    x = (3/2+3/10*sin(2*pi*t)+sin((2*pi)/3*t)-sin((2*pi)/10*t)).*sinc(t);
```

And for the plot:

```
function Ex1 = Ex1()
    t = -5:0.1:5;
    plot(t,x(t));
    xlabel('t');
    ylabel('x(t)');
```

See figure 1 for the result.

1.2 Exercise 2

From the given expression of $x(t)$ we see that the maximum angular frequency is $w_{max} = 2 \cdot \pi$ which equals in hertz: $w = 2\pi f \implies f = \frac{w}{2\pi} = \frac{2\pi}{2\pi} = 1$ Hz and the lower frequency is $w_{min} = \frac{2 \cdot \frac{\pi}{10}}{2\pi}$ Hz, the bandwidth of $x(t)$ is then $f_1 = f_{max} - f_{min} = 2 \cdot \pi - 2 \cdot \pi/10 = 2\pi w = 2\pi(\frac{2\pi}{2\pi} - \frac{2 \cdot \frac{\pi}{10}}{2\pi}) = 2\pi - 2 \cdot \frac{\pi}{10} = \frac{\pi 9}{5} = 1.8\pi$.
The sampling theorem states that the sample rate must be atleast two times larger then our max frequency 2π, hence sampling rate must be atleast 4π. And since $T_s = \frac{1}{f_s}$ means $T_s <= \frac{1}{4}$. Summary: The frequency of sampling must be $T_s = \frac{1}{4}$. And the bandwidth 1.8π.

1.3 Exercise 3

With the interval $T_s = \frac{1}{4}$ an almost identical graphical representation of the original signal is shown, see figure 2.

1.4 Exercise 4

The sampling theorem specifies a minimum-sampling rate where a properly sampled signal can be reconstructed from the samples. The rate $T_s = \frac{1}{4}$ that we solved in Exercise 2 will then be enough to reconstruct the signal.

1.5 Exercise 5

The command *hold* in Matlab helps with drawing these figures you are about to see. By allowing us to draw over a already present plot helps us showcase continuous-time signals by using two instances to plot multiple functions. We plot equation a, b, c, d in figure 3,4,5,6, respectively. We progressivly see a closer representation of $x(t)$ (Orange in figures 3 - 6) from exercise 1.For equation d in figure 6 we use the value $r = 1000$ which gives an almost exact representation of $x(t)$.

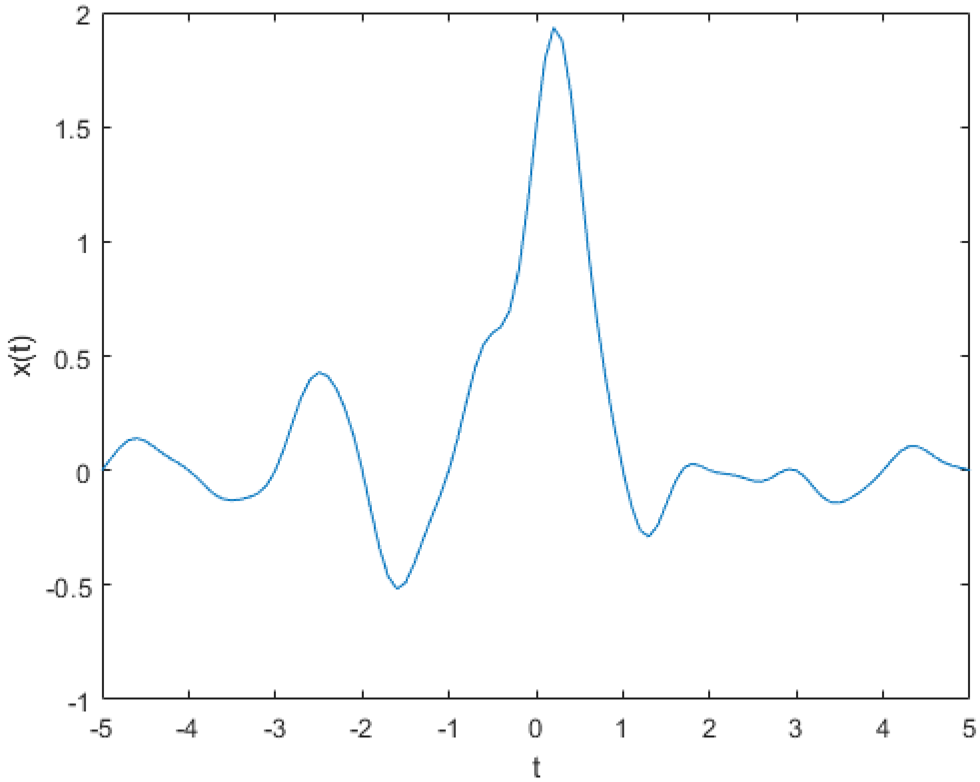

Figure 1: Exercise 1

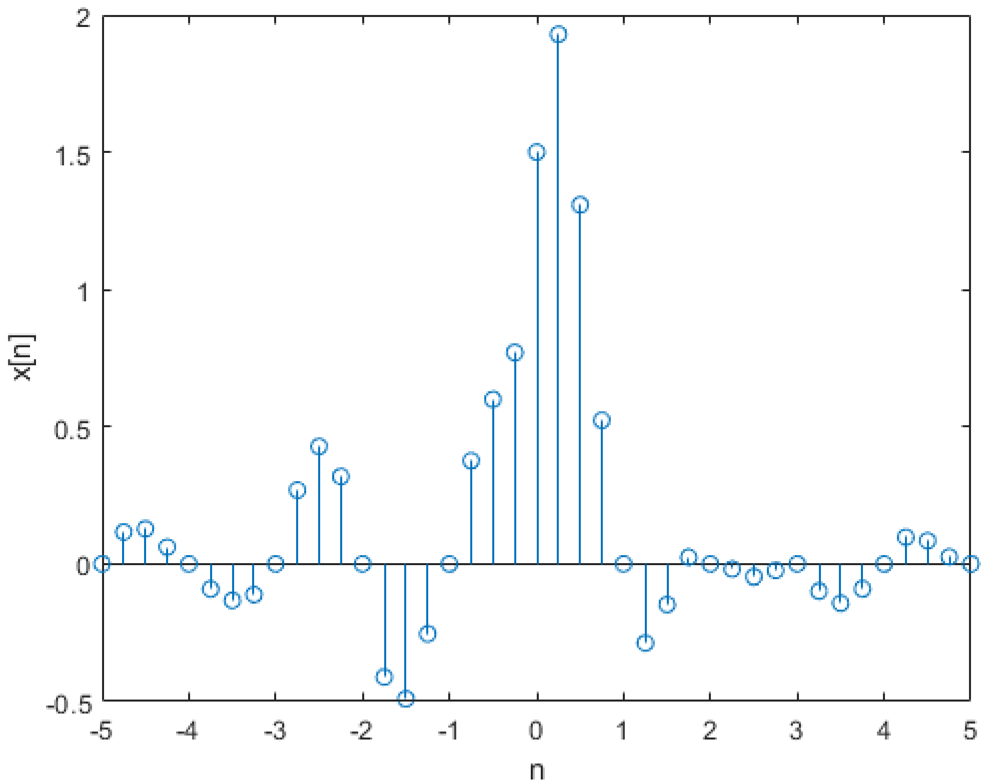

Figure 2: Exercise 3

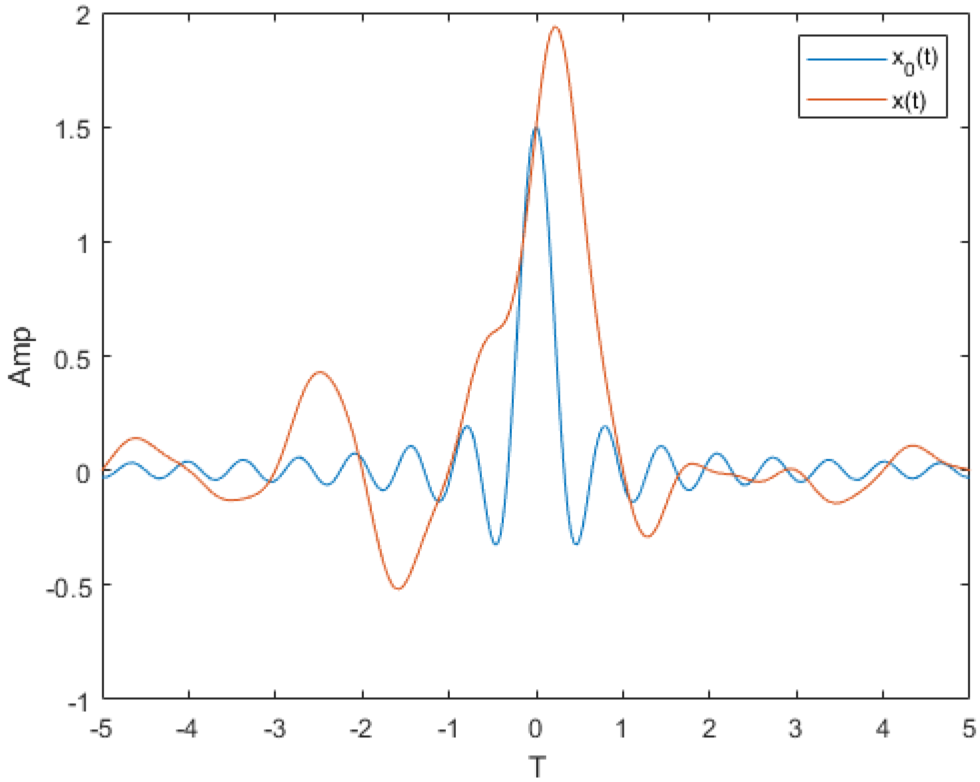

Figure 3: Exercise 5: a

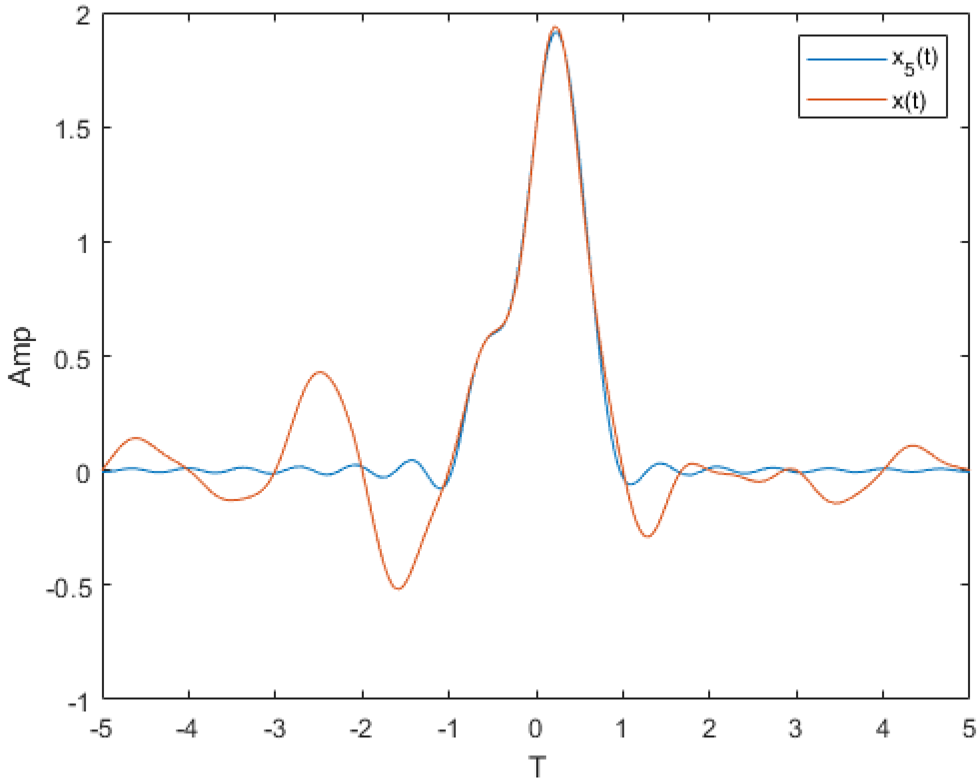

Figure 4: Exercise 5: b

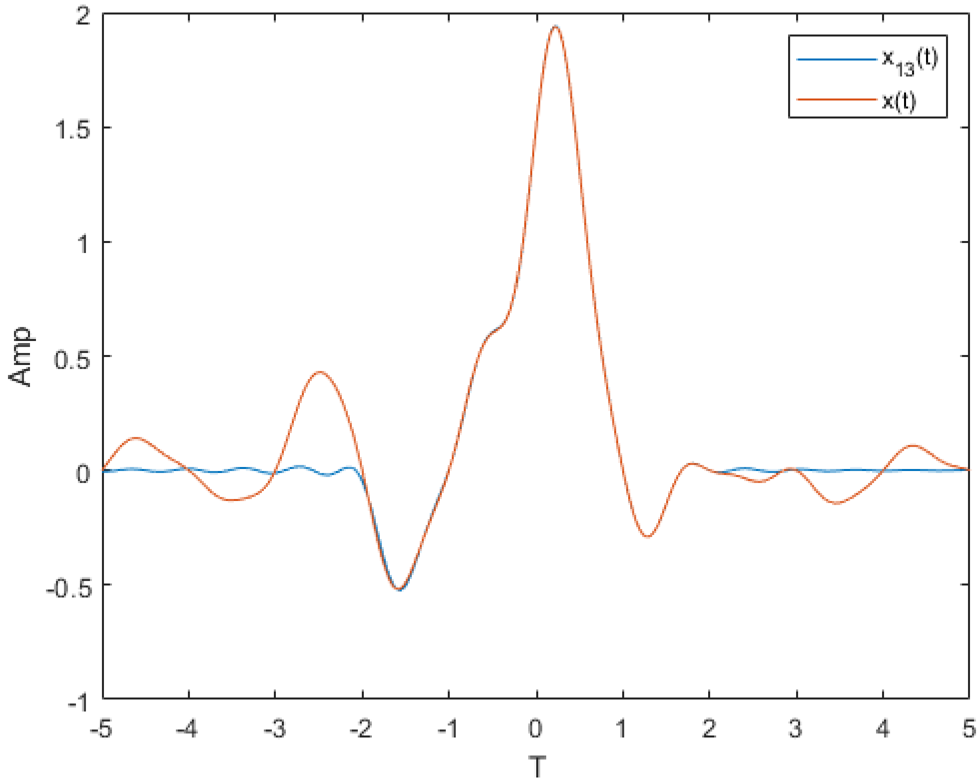

Figure 5: Exercise 5: c

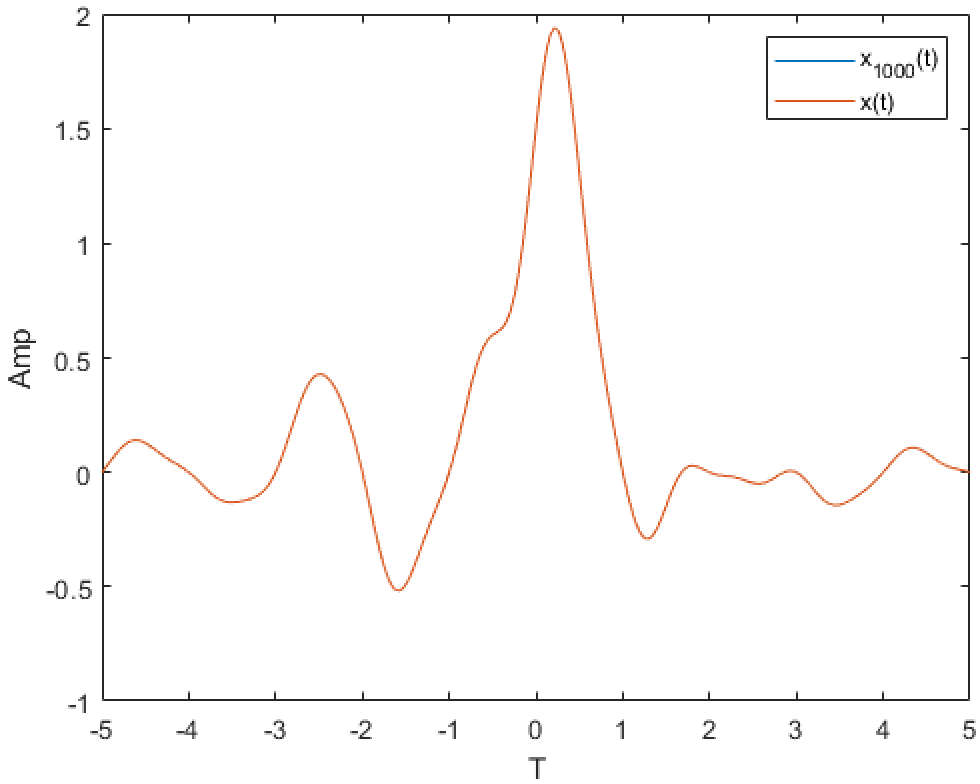

Figure 6: Exercise 5: d