

CENG 384 - Signals and Systems for Computer Engineers
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Homework 1

İşleyici, Osman Taylan
e2448496@ceng.metu.edu.tr

LastName2, FirstName2
xxxxxxx@ceng.metu.edu.tr

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1. (a)
(b)
(c)
(d)
- 2.

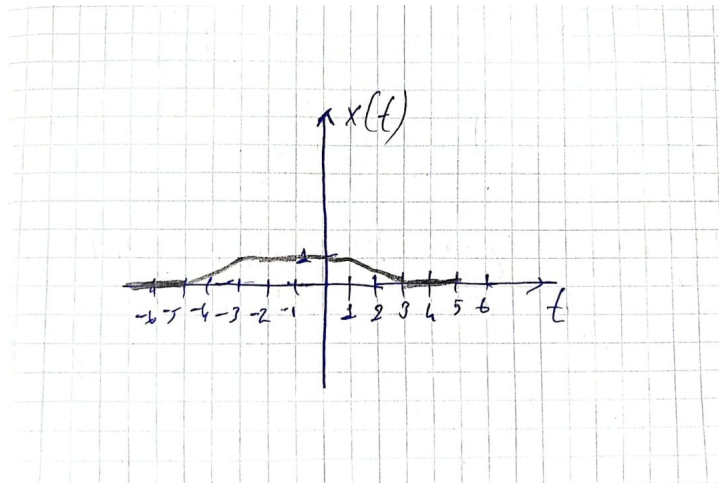


Figure 1: Signal $x(\frac{1}{2}t + 1)$

3. (a)
(b)
4. (a) The signal is periodic and its fundamental period is $\frac{2\pi}{3}$ since the fundamental period of signal $k * \cos(at + b)$ is determined by $\frac{2\pi}{a}$.
(b) The fundamental period of discrete signal $m\cos[an + b]$ is the smallest integer $\frac{2\pi k}{a}$ where k is any integer. Here the period of cosine part is 20, and the period of the sine part is 20 too. So the period of signal itself is least common multiple of these two periods, 20. The signal is periodic.
(c) Since there isn't any integer k which makes $\frac{2\pi k}{7}$ an integer. The signal is not periodic.
5. (a)
(b)
6. (a)
 - It has a memory since output depends on input $x(2t + 3)$.
 - It's not stable. We can prove this by counterexample, if $x(t) = 1$, $y(t) = t$ which is an unbounded output. So bounded inputs (1) yields unbounded outputs.
 - It's not causal since the output depends on inputs greater than t if $t > -3$.
 - It's linear since for two input signals x_1 and x_2 and their corresponding outputs y_1 and y_2 ; $ay_1(t) + by_2(t) = atx_1(2t + 3) + btx_2(2t + 3)$ is equal to $y_3(t) = tx_3(2t + 3)$ where $x_3 = ax_1 + bx_2$.
 - It's invertible since we can write a system $w(t) = \frac{2y(\frac{t-3}{2})}{t-3}$ whose output for the signal $y(t)$ is $x(t)$.

- The system is time varying because of two reasons, there is a time scaling on input $(2t + 3)$, and there is also a time multiplier on signal. Both these reasons are enough for time variance.
- (b)
 - The system has a memory since the output depends not only on $x[n]$ but infinitely many inputs before n .
 - The system is not stable, we can prove this by counterexample let's say our input is $x[n] = 1$ for every n . The output of the system would be $y[n] = \infty$ for every n . Since the output is unbounded while the input is bounded, system is not stable.
 - It's linear, for two inputs $x_1[n]$ and $x_2[n]$ the response of system to $ax_1[n] + bx_2[n] = \sum_{k=1}^{\infty} (ax_1[n-k] + bx_2[n-k])$ is equal to $ay_1[n] + by_2[n]$.
 - It's invertible, the output of system $w[n] = y[n+1] - y[n]$ for the input signal $y[n]$ is equal to $x[n]$.
 - It's time invariant since for input $x'[n] = x[n - n_0]$ the response of system $y'[n]$ is equal to $\sum_{k=1}^{\infty} x'[n-k] = \sum_{k=1}^{\infty} x[n - n_0 - k] = y[n - n_0]$.

7. (a)
(b)

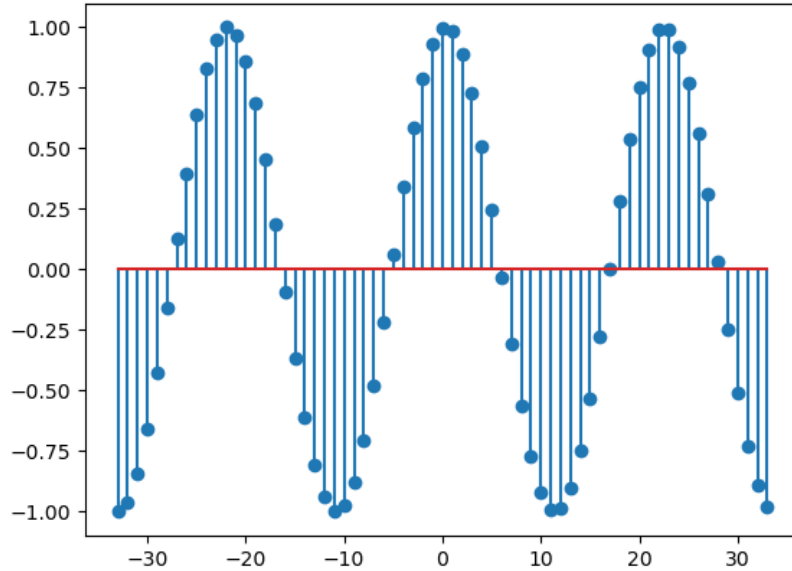


Figure 2: Output graphic for sine_part.b.csv

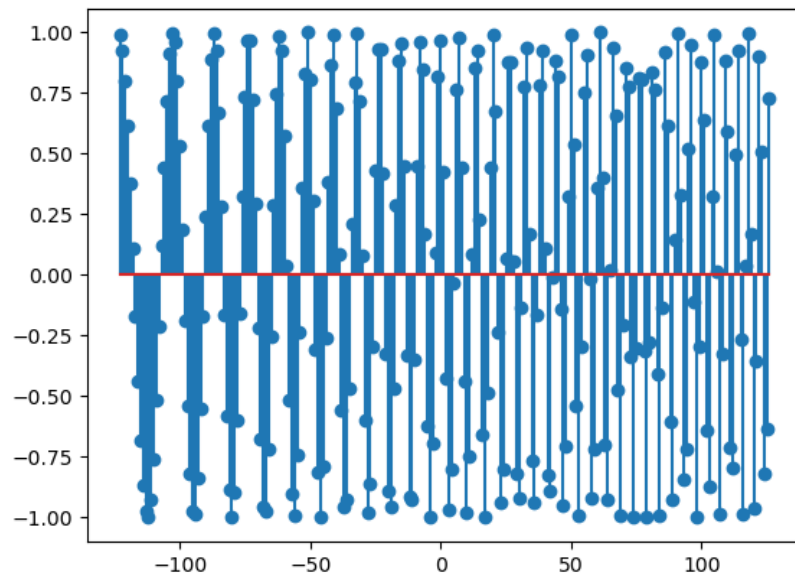


Figure 3: Output graphic for chirp_part.b.csv

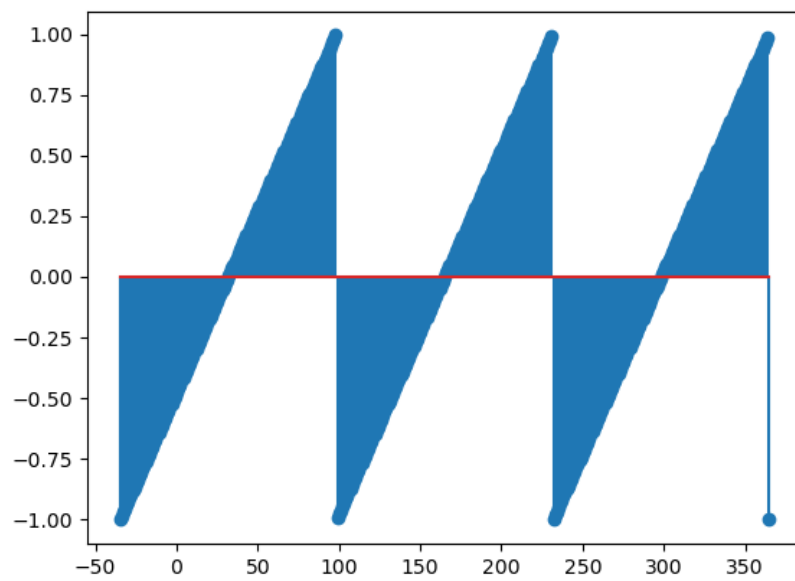


Figure 4: Output graphic for shifted_sawtooth_part.b.png