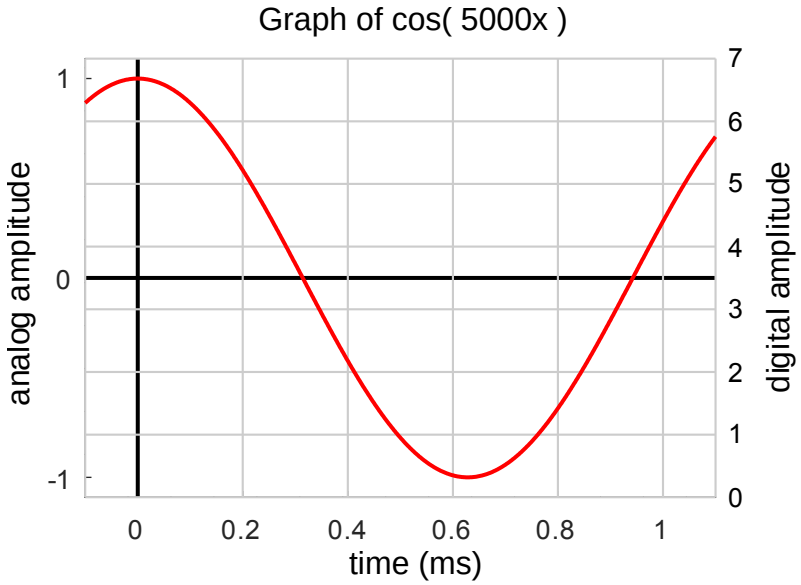
English name: _____

# Worksheet: Sampling an Analog Signal



The mathematical formula $\cos(5000t)$, graphed below with a domain of 0 ms to 1 ms, represents a sound wave of about 796 Hz. Complete the table to the right of the graph by determining the digital samples, sampling the signal at a rate of 5000 Hz (once every 0.2 ms) and with a resolution of 8 levels (3 bits per sample).

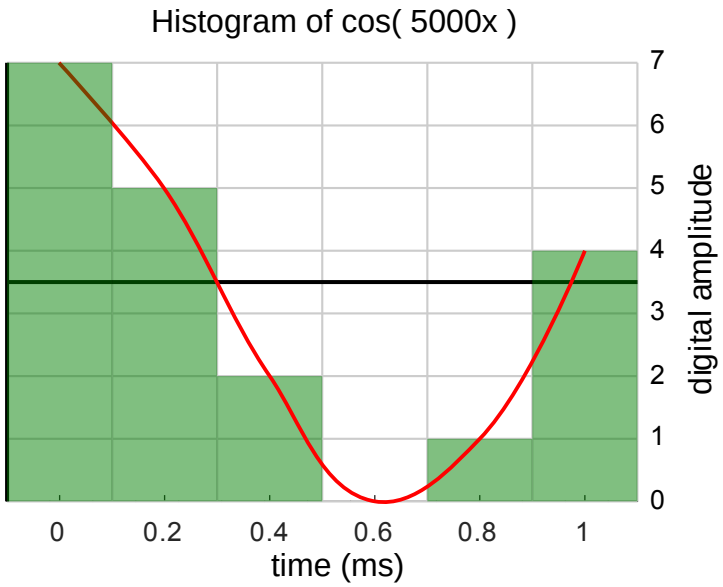



| Sampling Table | | |
|---|---|---|
| Time (ms) | Digital Amplitude | |
| | Decimal | Binary |
| 0.0 | 7 | 111 |
| 0.2 | 5 | 101 |
| 0.4 | 2 | 010 |
| 0.6 | 0 | 000 |
| 0.8 | 1 | 001 |
| 1.0 | 4 | 100 |

Write the sampled digital amplitudes as a bitstream in the box to the right.

111_101_010_000_001_100

Use the digital values from the table above to create a digital histogram of the original signal.



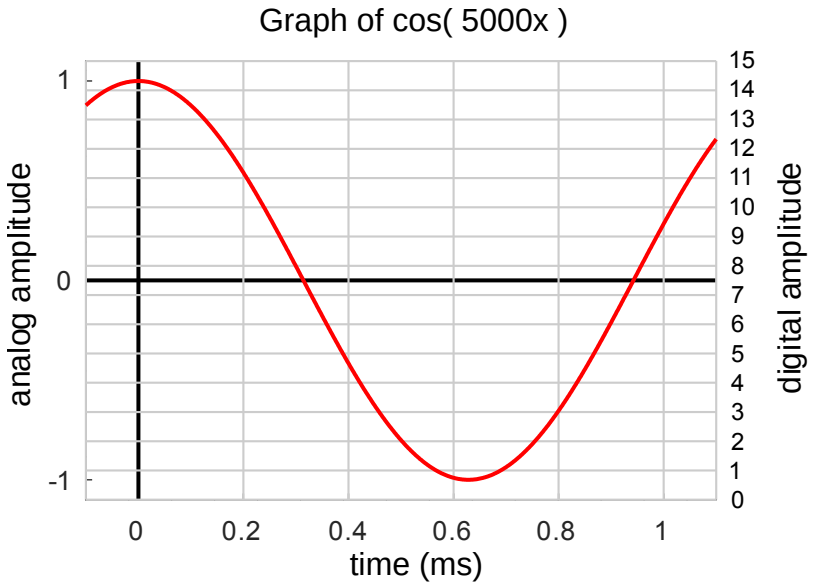

The red line joins the midpoints of the histogram with a slightly smoothed line.

English name: _____

# Worksheet: Sampling an Analog Signal



We will now see what happens if we increase the precision of the samples from 8 levels to 16 levels (from 3 bits per sample to 4 bits per sample). Complete the table to the right of the graph by determining the digital samples, sampling the signal at a rate of 5000 Hz (once every 0.2 ms).




| Sampling Table | | |
|---|---|---|
| Time (ms) | Digital Amplitude | |
| | Decimal | Binary |
| 0.0 | **14** | **1110** |
| 0.2 | **11** | **1011** |
| 0.4 | **5** | **0101** |
| 0.6 | **1** | **0001** |
| 0.8 | **3** | **0011** |
| 1.0 | **9** | **1001** |

Write the sampled digital amplitudes as a bitstream in the box to the right.

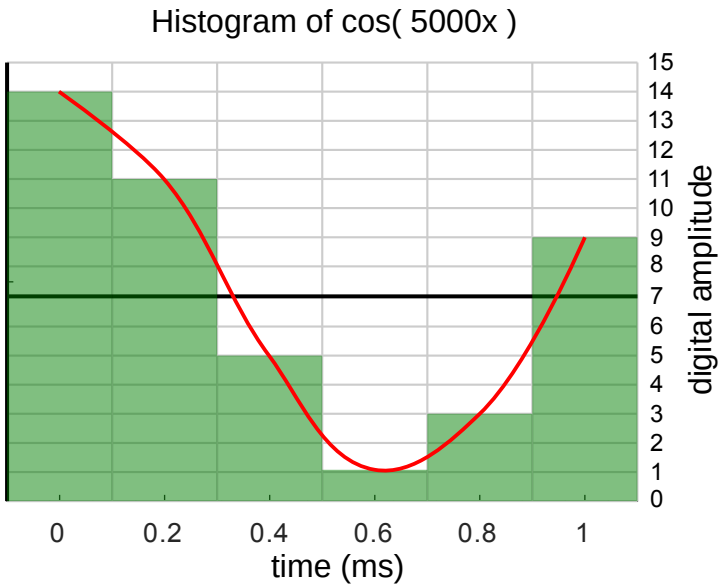
1110_1011_0101_0001_0011_1001

Length of bitstream for 3 bits per sample: 18

Length of bitstream for 4 bits per sample: 24

Percent increase: 33%

Use the digital values from the table above to create a digital histogram of the original signal.




The red line joins the midpoints of the histogram with a slightly smoothed line.

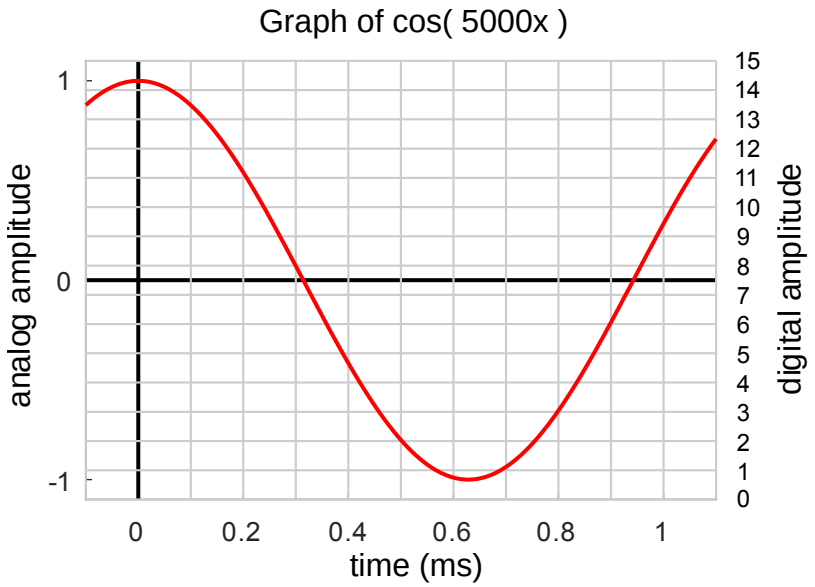
Increasing the ***precision*** (***bit depth***) of the sampling seems to have improved the ***fidelity*** of the signal slightly.

English name: _____

# Worksheet: Sampling an Analog Signal



This time we will double the sample rate from 5 kHz (5000 samples per second) to 10 kHz while holding the sampling precision at 16 levels (4 bits per sample). Complete the table to the right of the graph by determining the digital samples at the new sample rate of 10 kHz or one sample every 0.1 ms.




| Sampling Table | | |
|---|---|---|
| Time (ms) | Digital Amplitude | |
| | Decimal | Binary |
| 0.0 | **14** | **1110** |
| 0.1 | **13** | **1101** |
| 0.2 | **11** | **1011** |
| 0.3 | **8** | **1000** |
| 0.4 | **5** | **0101** |
| 0.5 | **2** | **0010** |
| 0.6 | **1** | **0001** |
| 0.7 | **1** | **0001** |
| 0.8 | **3** | **0011** |
| 0.9 | **6** | **0110** |
| 1.0 | **9** | **1001** |
| 1.1 | **12** | **1100** |

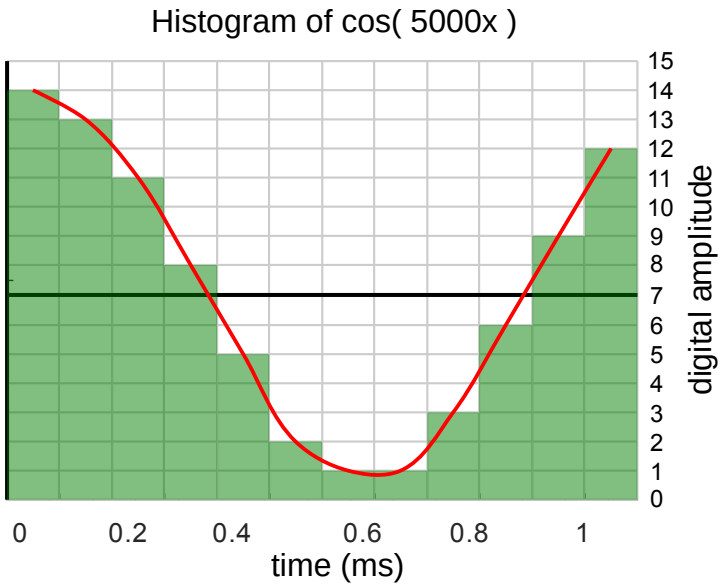
Write the sampled digital amplitudes as a bitstream in the box below.

1110_1101_1011_1000_0101_0010
0001_0001_0011_0110_1001_1100

How does the length of the bitstream for the signal sampled with with 4-bit precision and at a sample rate of 10 kHz compare to the length of the bitstream for the signal sampled with 4-bit precision and at a sample rate of 5 kHz? Write in a complete sentence.

*The length of the bitstream for the signal sampled at 10 kHz is double the length of the bitstream for the signal sampled at 5 kHz.*

Use the digital values from the table above to create a digital histogram of the original signal.




The red line joins the midpoints of the histogram with a slightly smoothed line.

Increasing the ***sample rate*** has also improved the ***fidelity*** of the signal.