MULTIMEDIA UNIVERSITY

PDS0101 Introduction to Digital Systems

Tutorial 1 SAMPLE SOLUTIONS

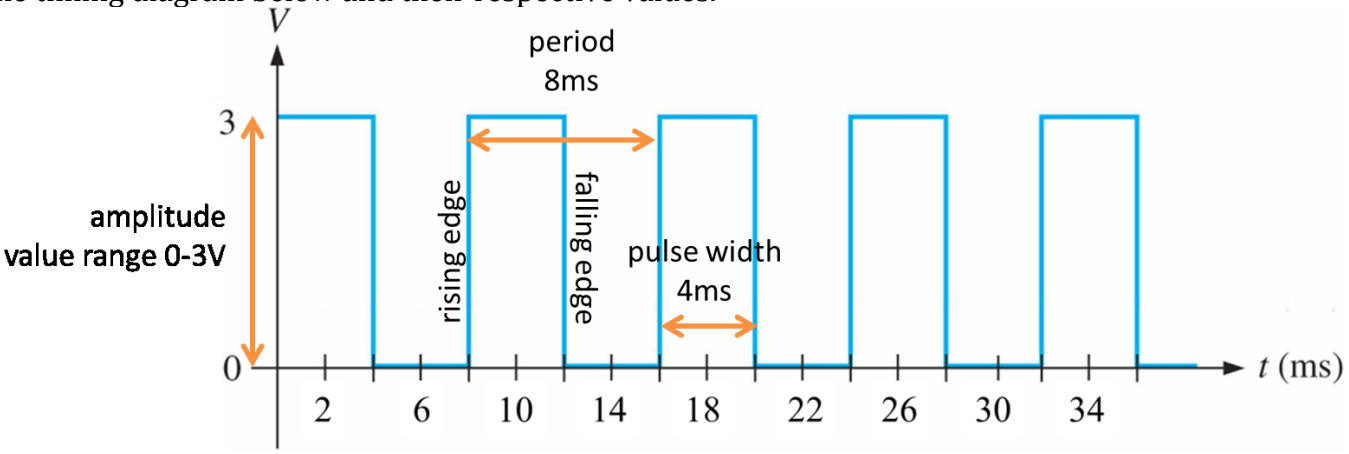
Tutorial outcomes

By the end of today's lab, you should be able to

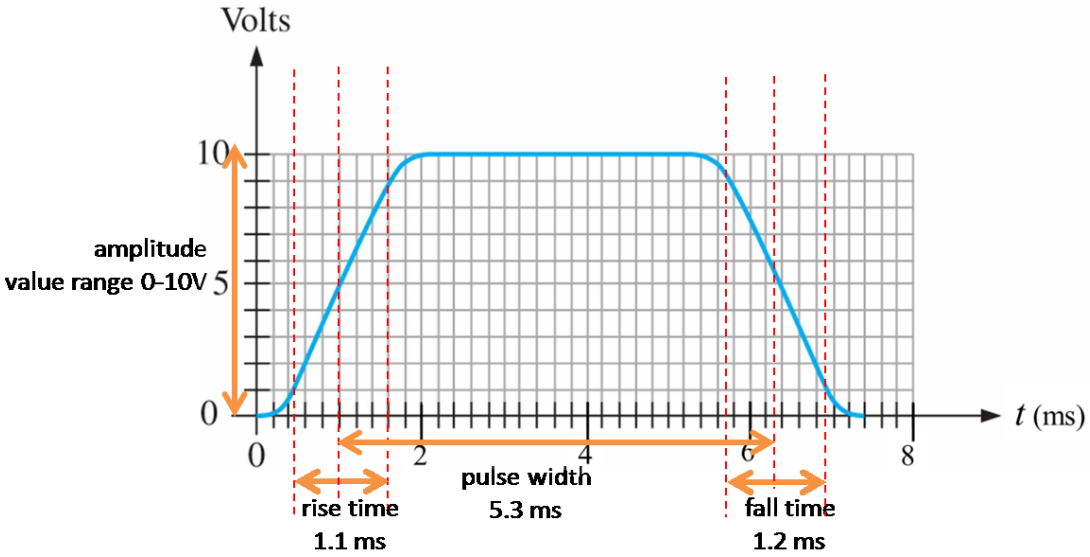
- identify differences between digital and analog quantities
- show how voltage levels can be used to represent digital quantities
- describe various waveform properties

Theory based questions

Identify and indicate the amplitude, rising/falling edge, period and pulse width components in the timing diagram below and their respective values.



Identify and indicate the amplitude, rise time, fall time and pulse width components in the timing diagram below and their respective values.



Knowing the period of a periodic waveform, how do you find the frequency?
The period value is the inverse of frequency. To find the frequency, divide one (1) with the value of the period (in seconds).

What is the meaning of the term *binary*?
Binary is a numeric representation system where values are represented by two digits only – 0 and 1. It can also be used to signify truth values of true or false, and on or off.

Define the following storage words in terms of its capacity

a) bit — *- binary digit (one digit)*
b) byte — *- eight bits ← common measurement term*
c) tayste — *- two bits (quarter byte)*
d) nybble — *- four bits (half byte) ← important in adders*
e) kilobyte — *- 1024 bytes NOT 1000 (except for communication)*
f) word — *- 16 bits – 2 bytes*
g) doubleword — *- 32 bits – 2 words*
h) playte — *- same as word*
i) dynner — *- same as double word*

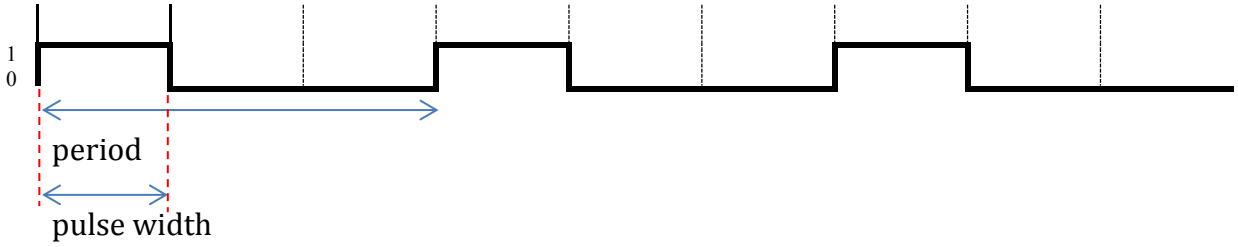
What are the advantages and disadvantages of the digital domain over analog?

Data Processing and Transmission – more efficient and reliable
Data Storage – more compact storage and greater accuracy and clarity in reproduction
Ease of design – In switching circuits, only the range in which the voltage or current fall is important not the exact values
Accuracy and precision are easier to maintain – In analog systems, voltage and current signals are affected by temperature, humidity but in digital systems, info. does not degrade
Easy Programmable operation
Less affected by noise since exact value is not important in digital systems
Ease of fabrication on IC chips – analog devices cannot be economically integrated.

Applied knowledge questions

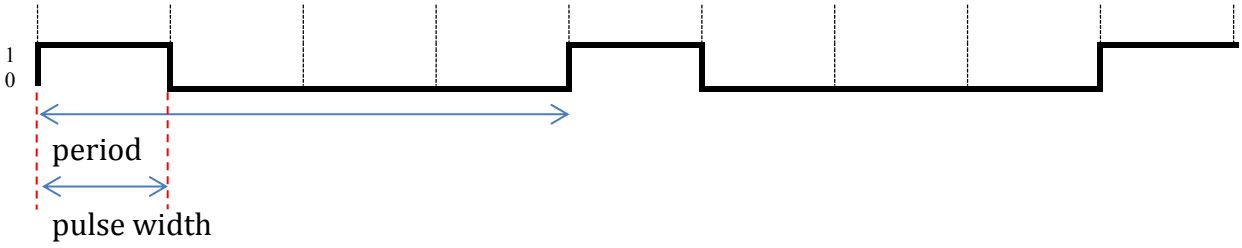
Identify the pulse width and period then calculate the *duty cycle* of the signals in the timing diagram shown below

A



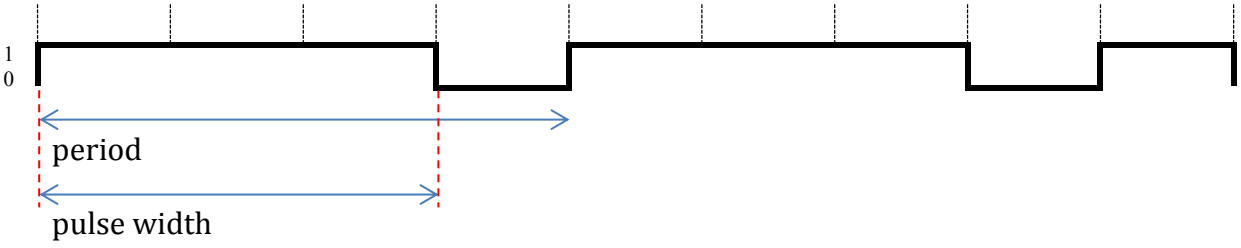
duty cycle 33%

B



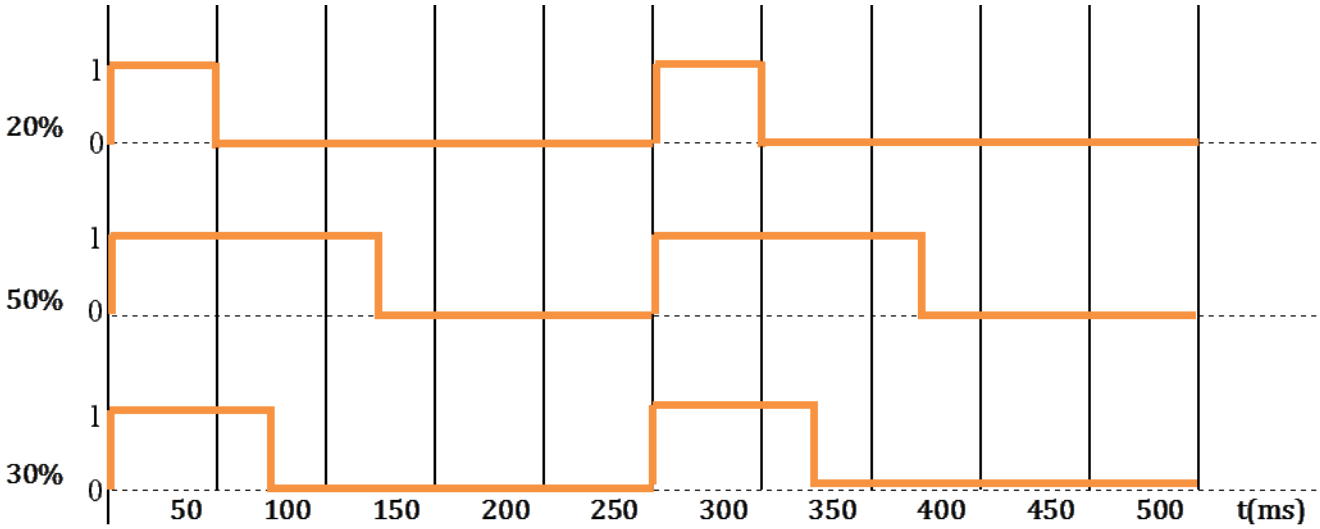
duty cycle 25%

C



duty cycle 75%

If given the frequency of a periodic signal is at 4Hz, use the following timing diagram scale to draw a signal when the duty cycle is at (a) 20%, (b) 50% and (c)30%

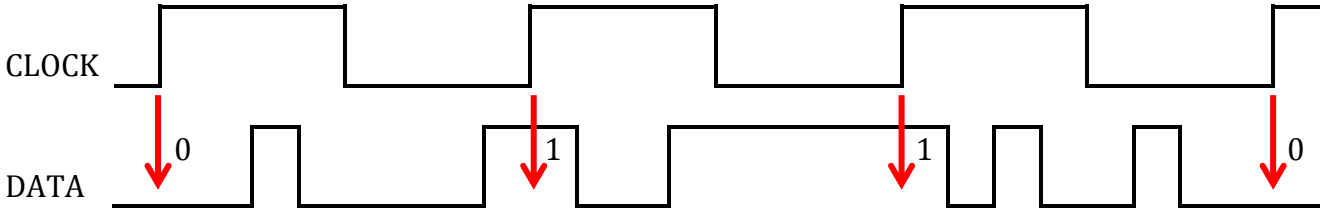


Calculate period with given frequency
T = 1/f = ¼ = 0.25s = 250ms

If binary data is transferred on a USB2.0 connection at a rate of 480Mbps, how long will it take (in theory) to transfer 4MB of data?

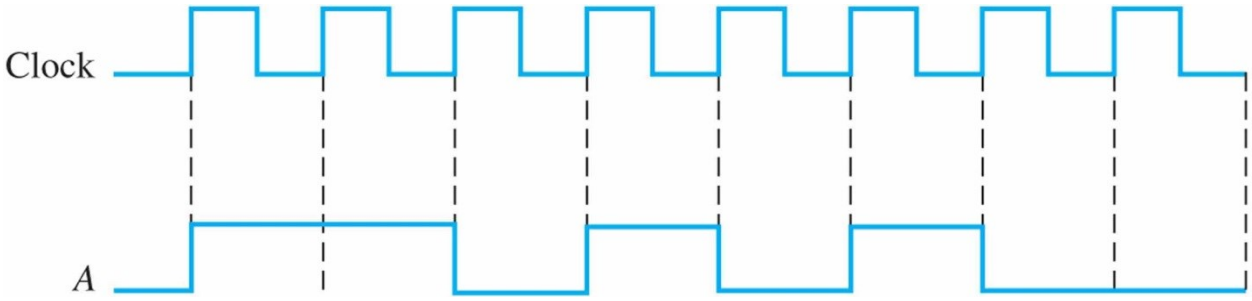
Transfer rate of USB2.0 *= 480Mbps*
= 480000000 bits per second
File size *= 4MB*
= 4×1024×1024 Bytes = 4194304 Bytes
= 33554432 bits
Time to transfer file *= 33554432 / 480000000*
= 0.06 seconds!

NOTE: in reality USB2.0 speeds are never achieved because of overhead/checking/noise/hardware limitations. The usual speeds of an average USB2.0 drive transfers at 3.5Mbps which means the file takes ~10 seconds to transfer.



Using the timing diagram above, what is the bit sequence transmitted above if given that the sampling is done upon the rising edge of the clock signal

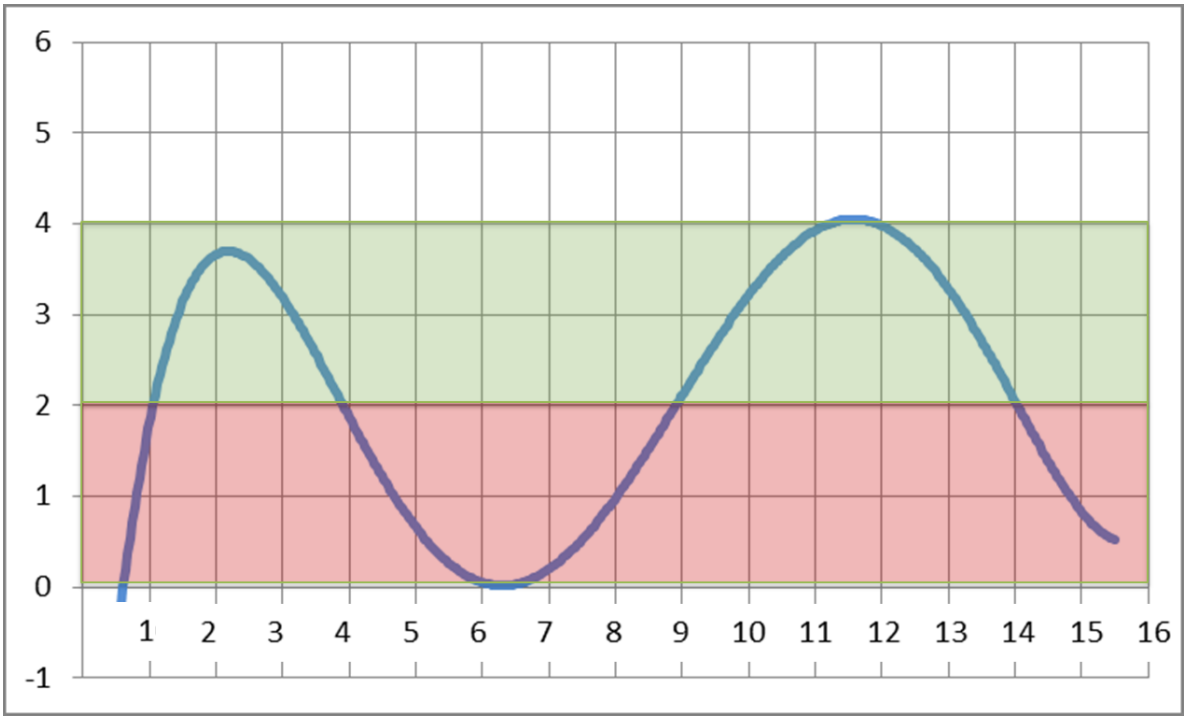
0110



Based on the waveform above, determine

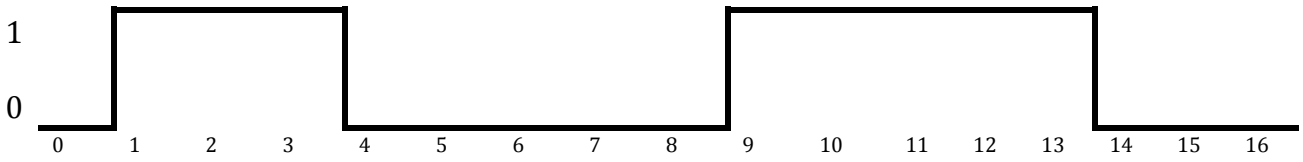
- The bit time if given the reference clock is running at 500Hz
- The bit sequence transferred by A
- The total time to transfer the bits serially
- The total time to transfer the same bits in parallel

Bit time *= period of clock*
= 1/frequency = 1/500 = 0.002 sec = 2 miliseconds
Bit sequence *= 11010100*
Transfer time *= 8 bits × 2ms = 16ms*
Parallel TX *= 2ms*



The waveform diagram above shows a recorded analog signal of voltage against time in seconds. Draw the resulting binary digital waveform assuming that an ADC samples this signal once (1) every second after the rising edge of its clock signal and given that TTL levels for high

are between 2-4V and low between 0-1V. It can be assumed that any values in the *unacceptable range* fall to low.



Based on threshold values, the green area in the graph will sample to 1 (high) whilst the red area will sample to 0 (low). The red area also takes into account the 'unacceptable range'
