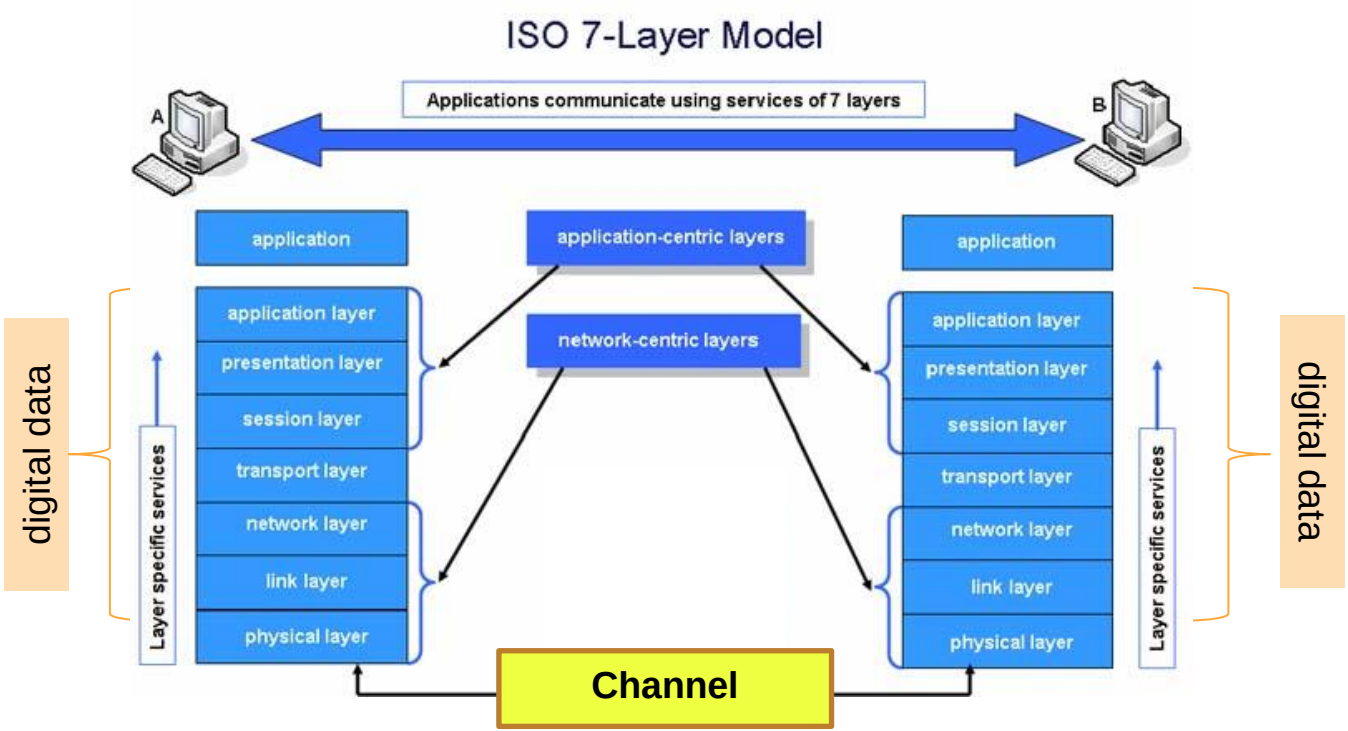
World of Signaling

Analog vs Digital

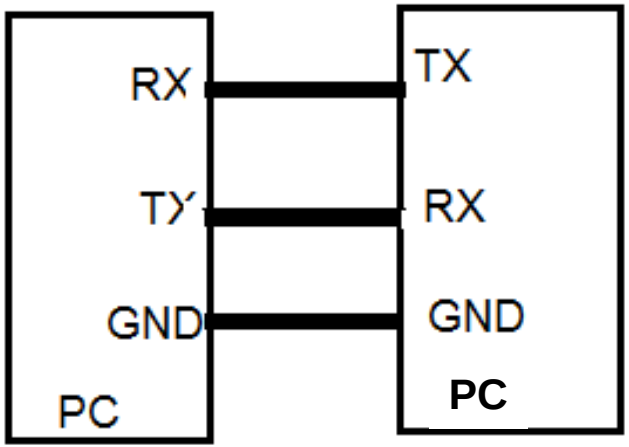
How can we communication between devices?



What type of signal will be in the transmission channel ?

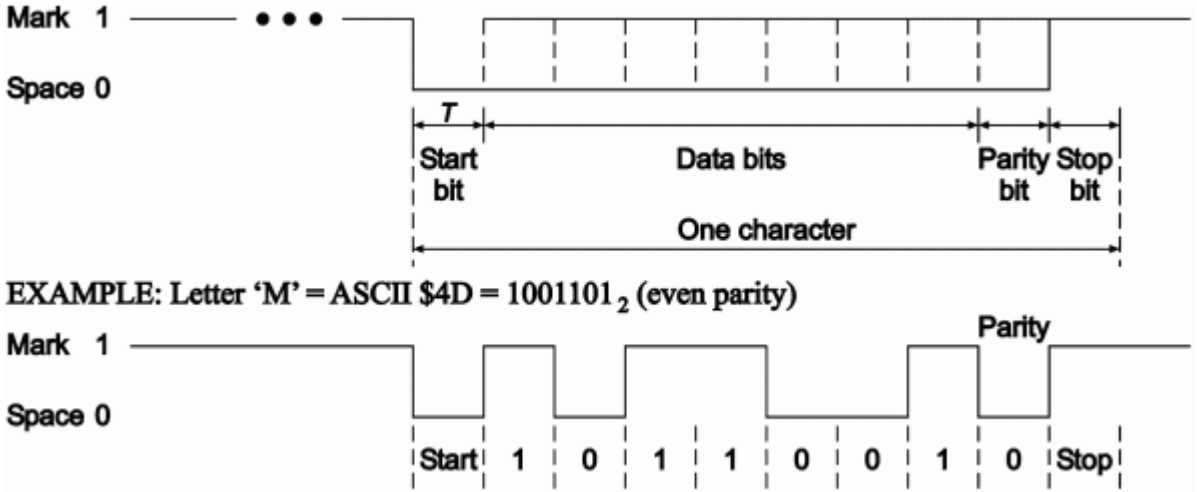
Data Communications

- Lab Experiment -> **RS232 Serial Communication**



DB9 connector **DB9 connector**

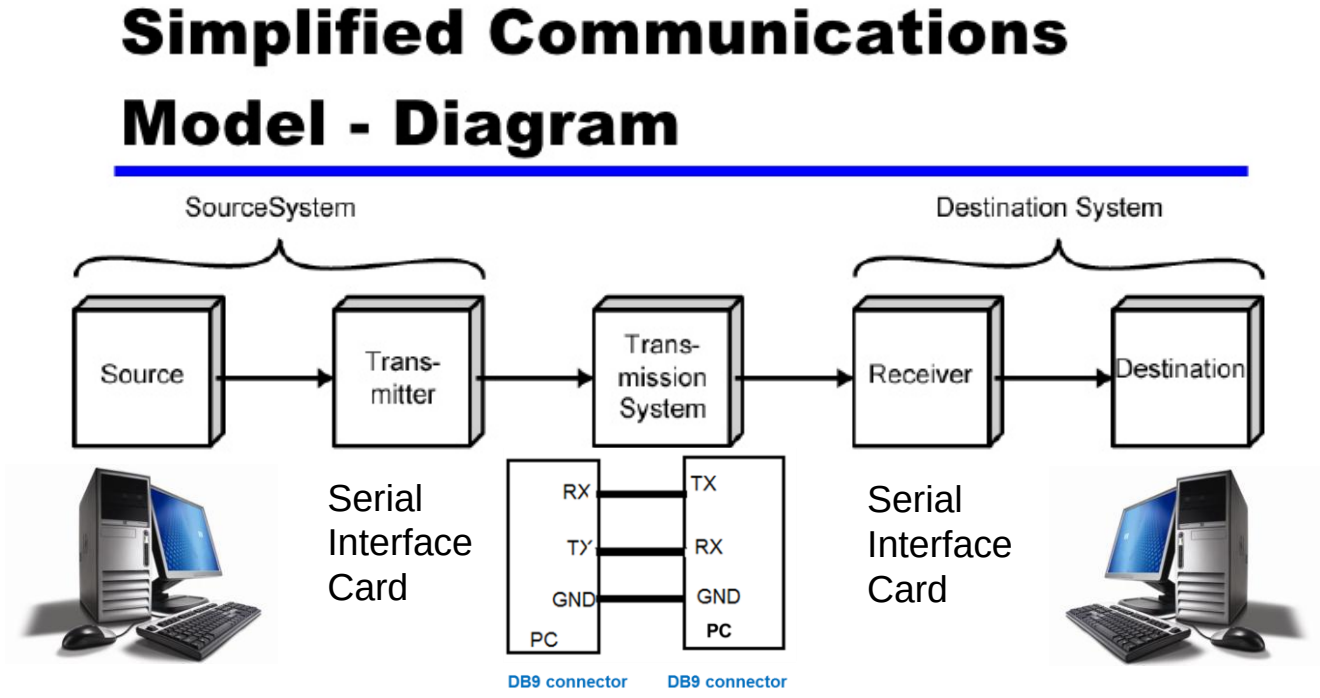
Data Format vs Data Speed



What type of signal will be in the transmission channel ?

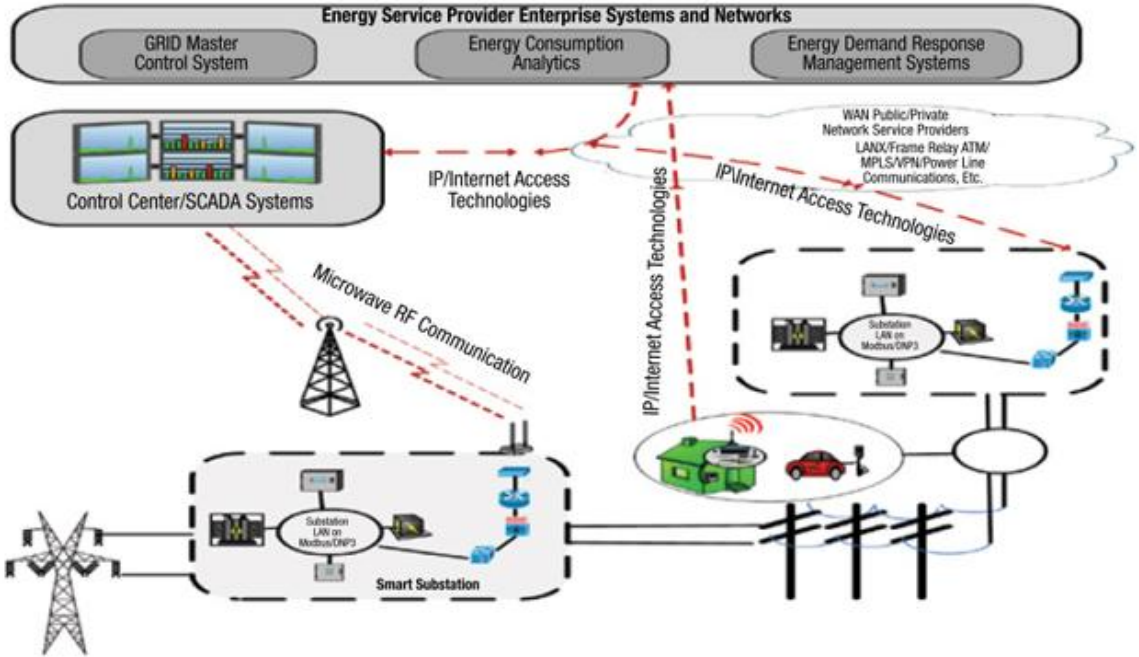
Data Communications

What types of signal are transmitted through Transmission System (channel) ?



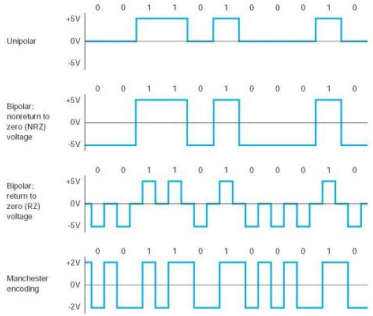
Data Communications

- Real world communication through several types of transmission systems

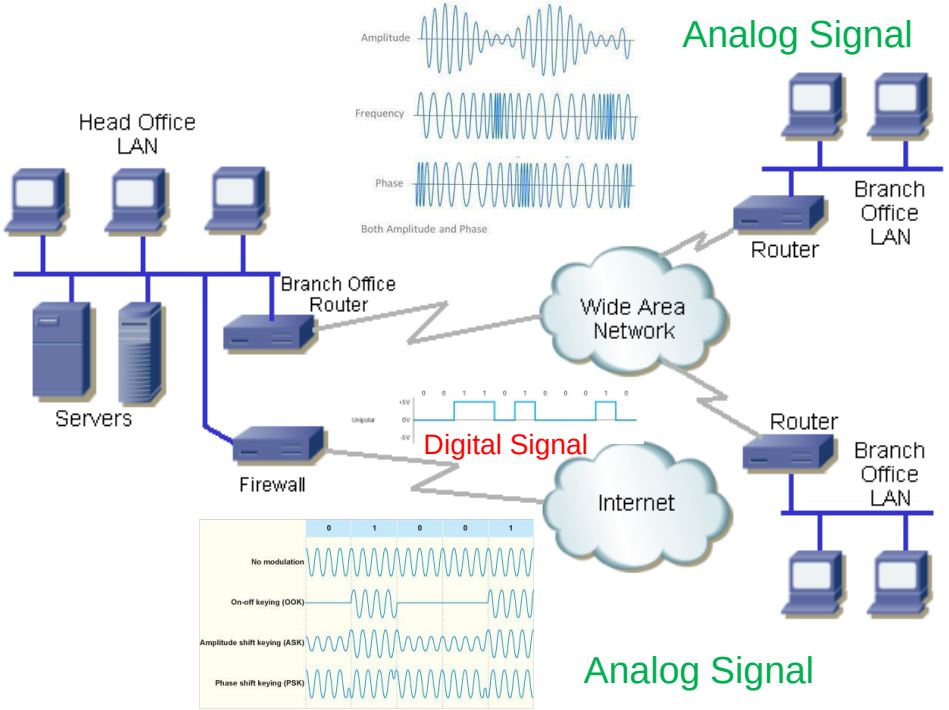


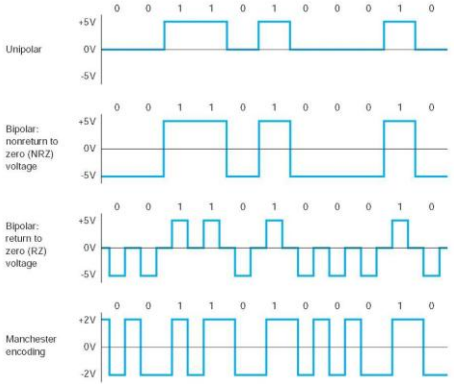
Actual Signal in Transmission System

- Both digital and analog signals -> which one do you know ?



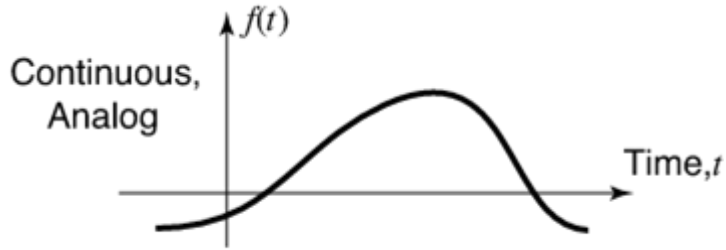
Digital Signal



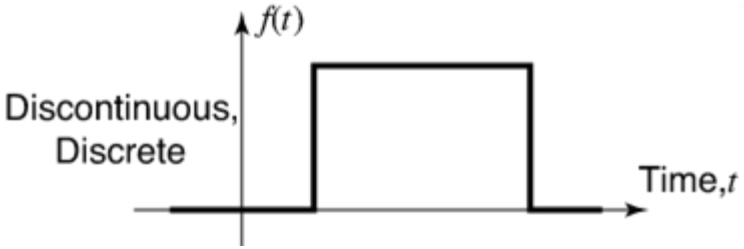


Digital Signal

Can you tell the difference?

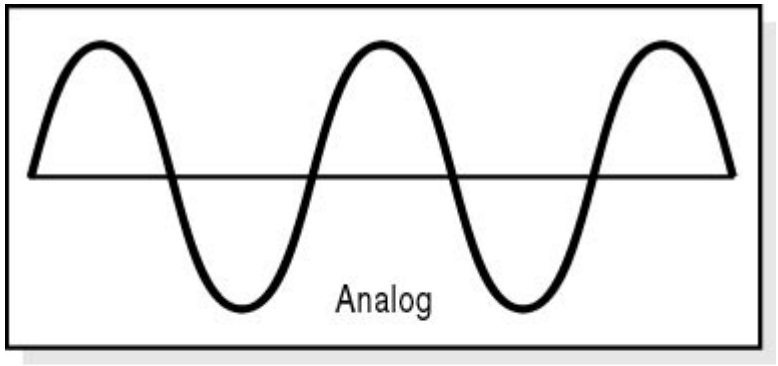


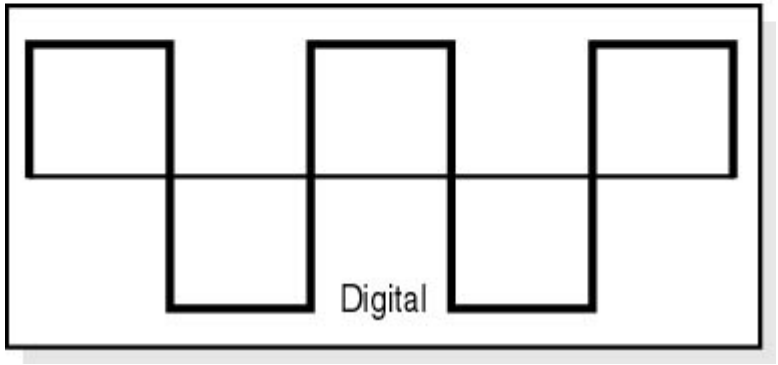
- **Continuous wave**: Continuous range of values to represent information
- **Example:** Human voice in air, analog electronic devices.



- **Discrete Wave:** discrete or discontinuous values to represent information
- **Example:** Computers, CDs, DVDs, and other digital electronic devices.

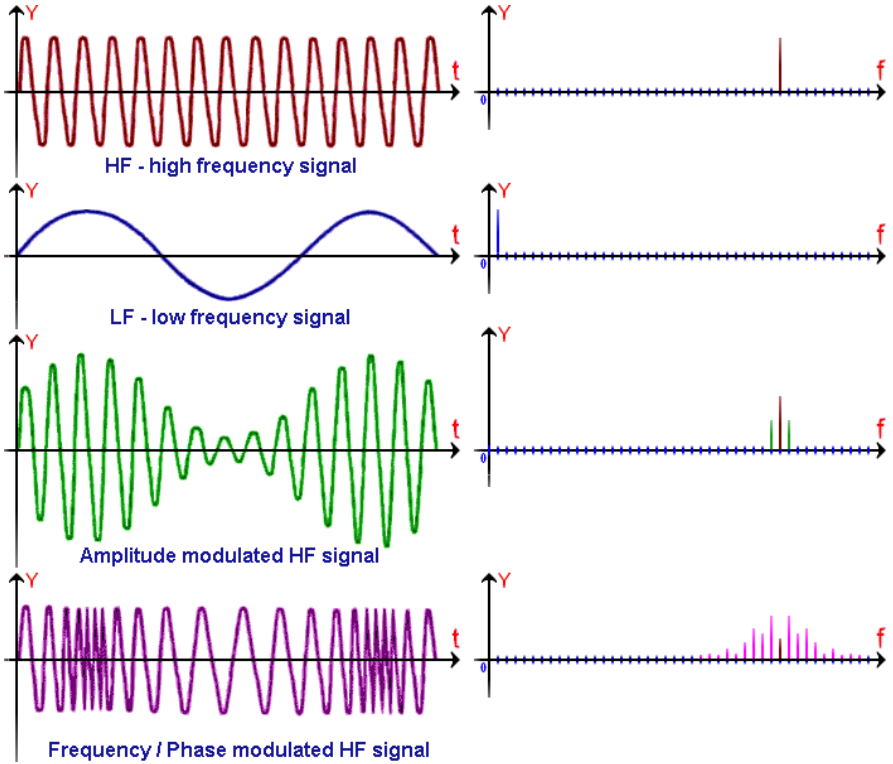
Signal Properties

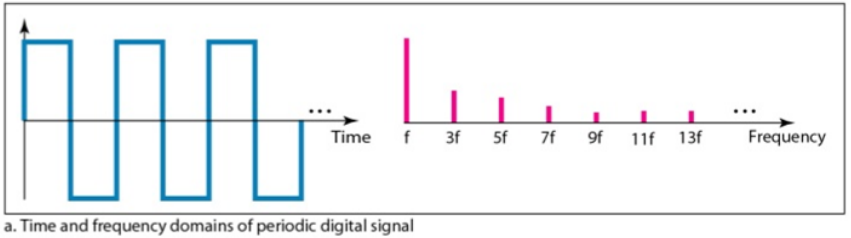




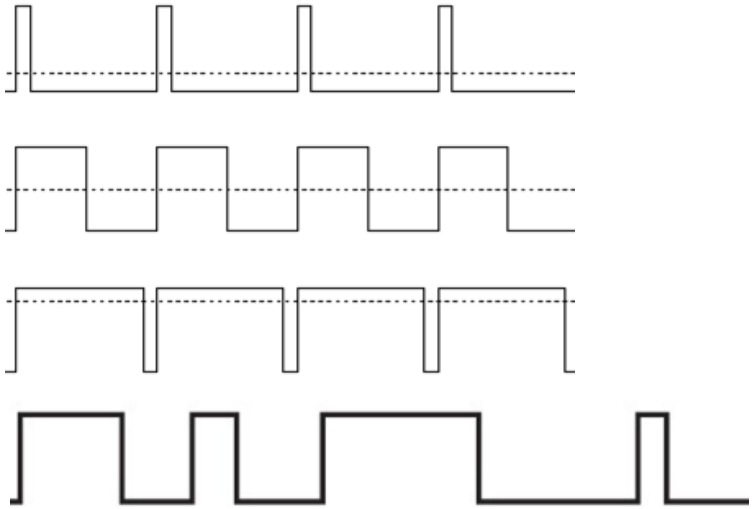
- Frequency / period (T)
- Amplitude
- Phase shift / Delay

What would be the difference of signal properties?

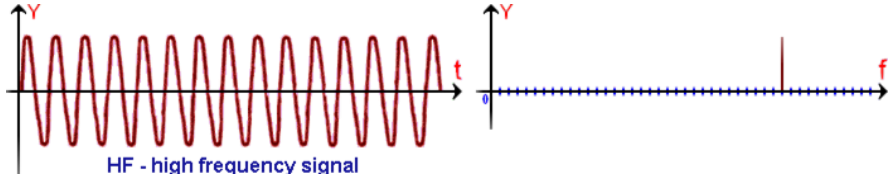


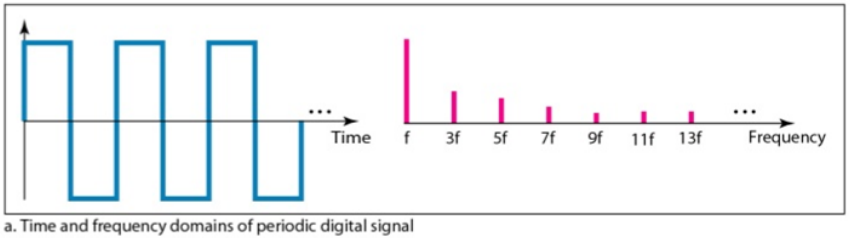


a. Time and frequency domains of periodic digital signal



What would be the frequency difference?





a. Time and frequency domains of periodic digital signal

Periodic Analog Signal

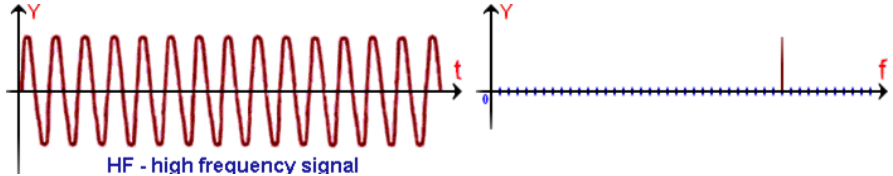
Single frequency (f = x Hz (Cycles/sec))

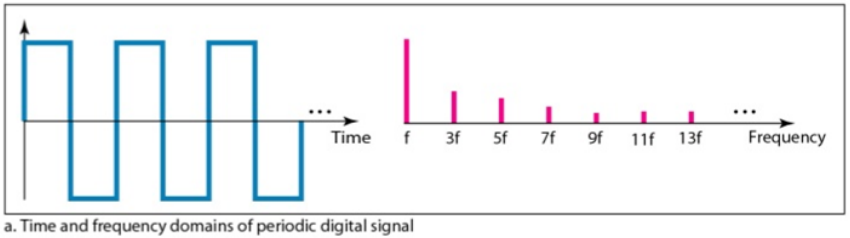
Periodic Digital Signal

Pulse frequency (p = x Hz (Cycles/sec))

Actual Frequency spectrum (p <= f < inf)

What would be the Period difference?





a. Time and frequency domains of periodic digital signal

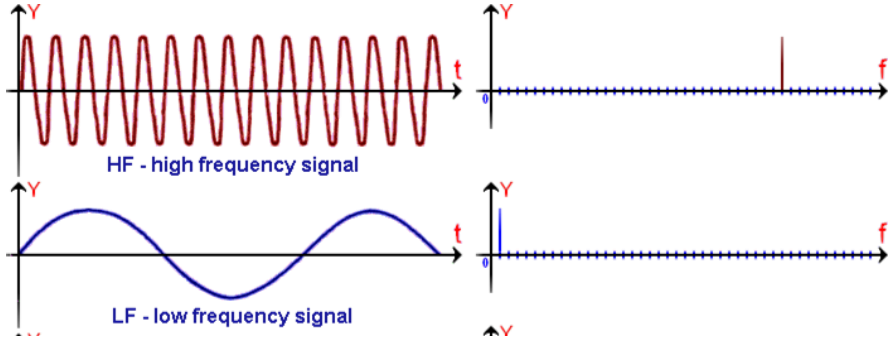
Periodic Analog Signal

Signal Period (T = 1/f = 1/x sec)

Periodic Digital Signal

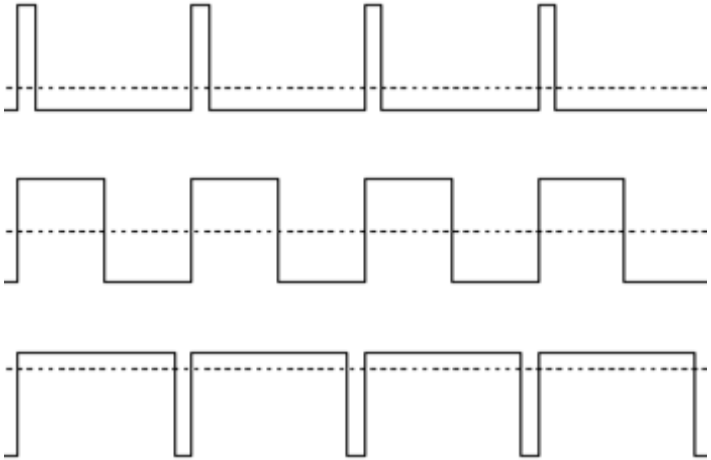
Pulse Period (T = 1/ x sec)

What would be the difference?



Periodic Analog Signal

Different Frequency (f) & Period (T) difference

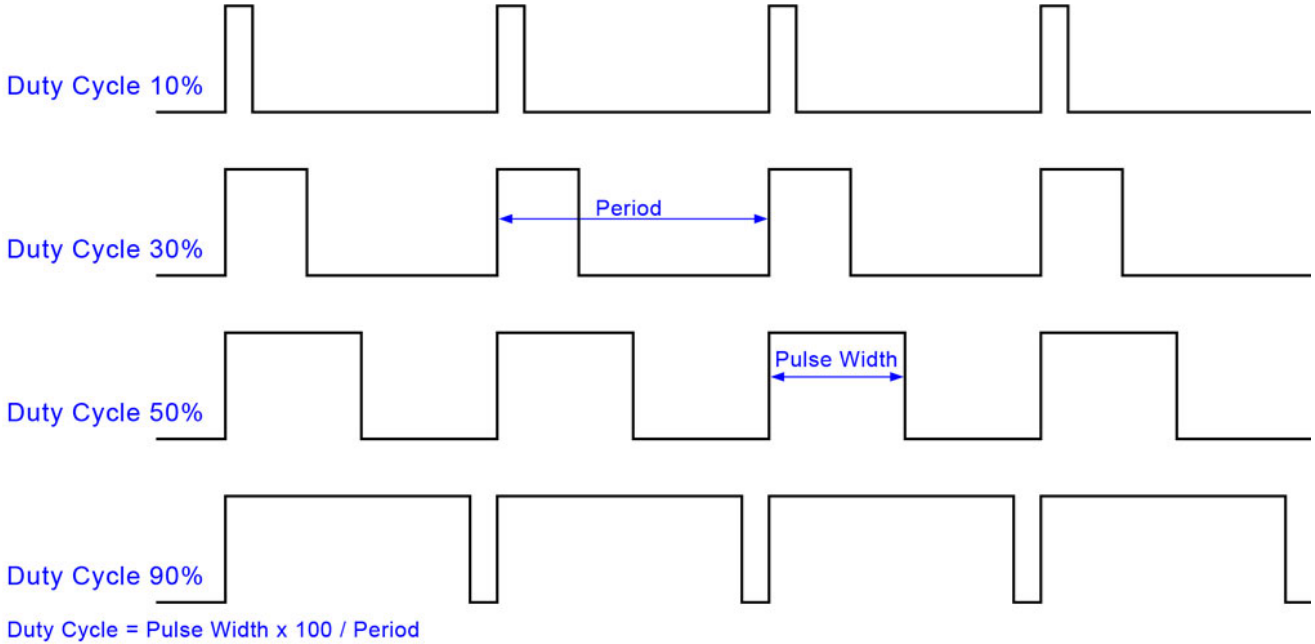


Periodic Digital Signal

Same Pulse Freq. (f) & Period (T)

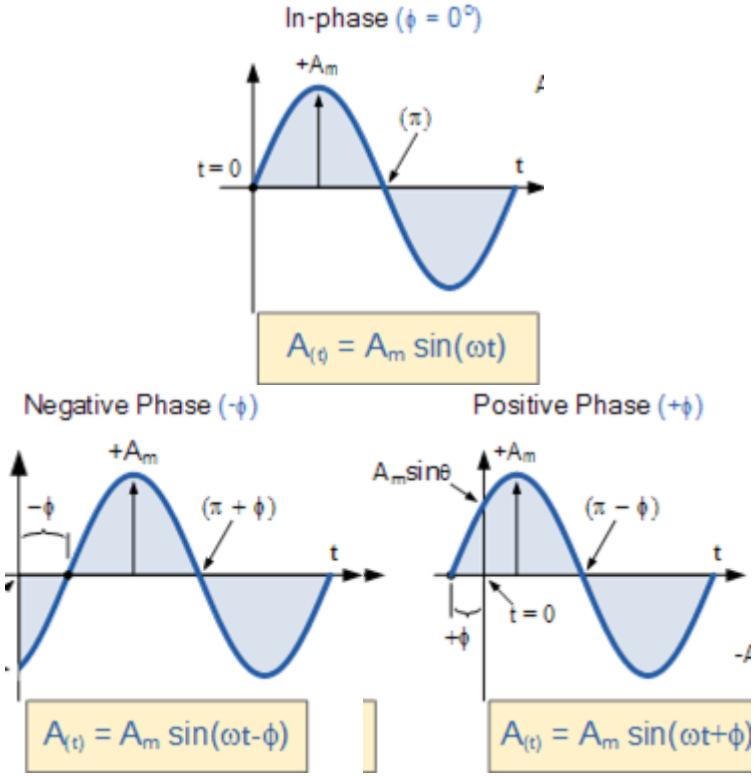
Active pulse duration Difference (pulse width)

Digital Pulse width

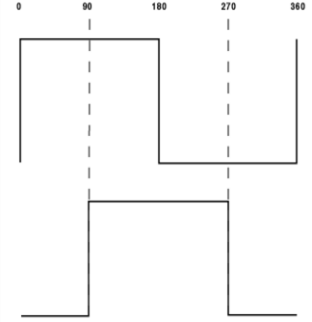


Duty Cycle = Pulse width x 100 / Period

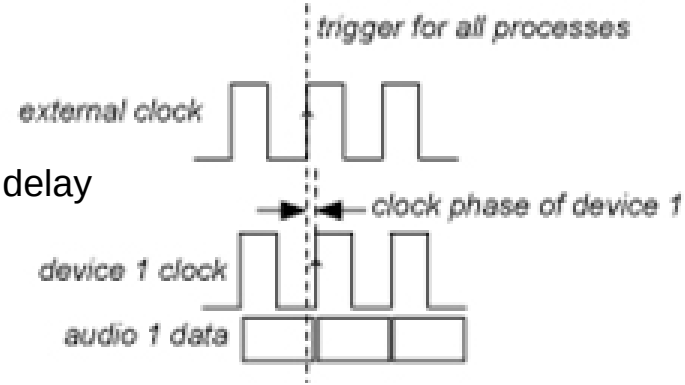
Analog Phase Shift vs Digital Delay



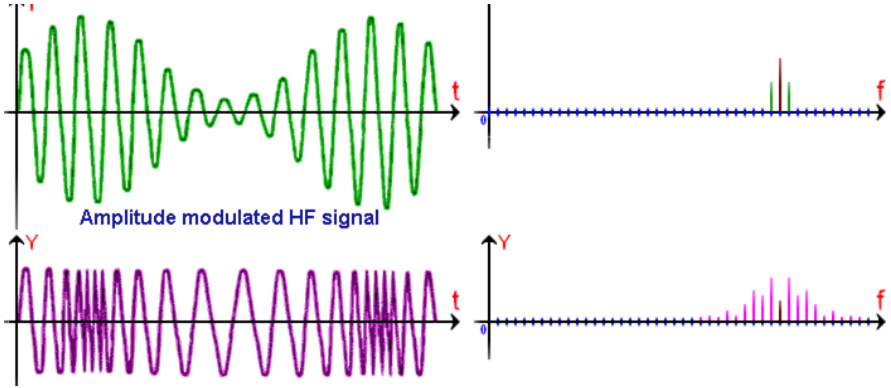
Data delay

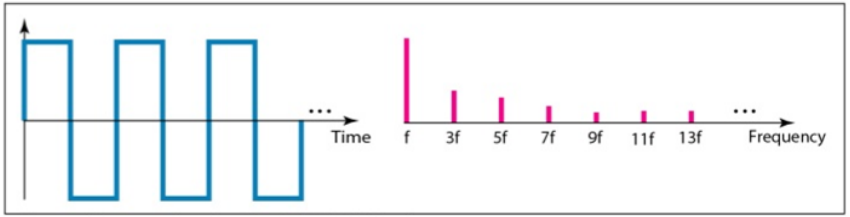


Clock delay



Composite Signal (Multi-Frequency Signal)





a. Time and frequency domains of periodic digital signal

Frequency Spectrum

- Multi-frequency spectrum
- Frequency Bandwidth = | f_max - f_min |

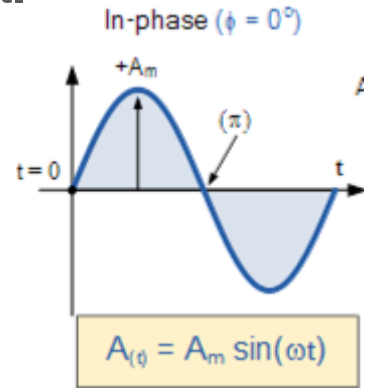
Frequency Spectrum

- Multi-frequency spectrum
- Frequency Bandwidth = | f_max - f_min |

= **inf**

การทดลองที่ 6: **Signal Generation**

Analog Signal



6.1: Sine wave in MATLAB (sin(zeta))

sin(2*pi*_f_*_t_) / sin(2*pi*t/T)

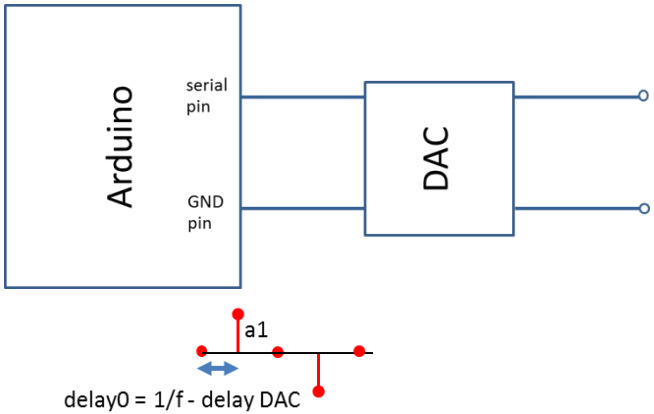
Digital Signal (PWM)

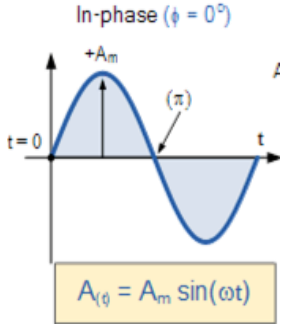
6.2: Sine wave in Arduino

(sin(zeta) -> PWM)+ Low Pass Filter (RC) circuit

การทดลองที่ 6: **Signal Generation**

6.3: Sine wave in Arduino (sin(zeta)) + DAC (Digital to Analog Conversion)





Kahoot

Calculating Signal Properties

https://play.kahoot.it/#/?quizId=2d387a46-cd05-498e-9aa9-acb417c1378e