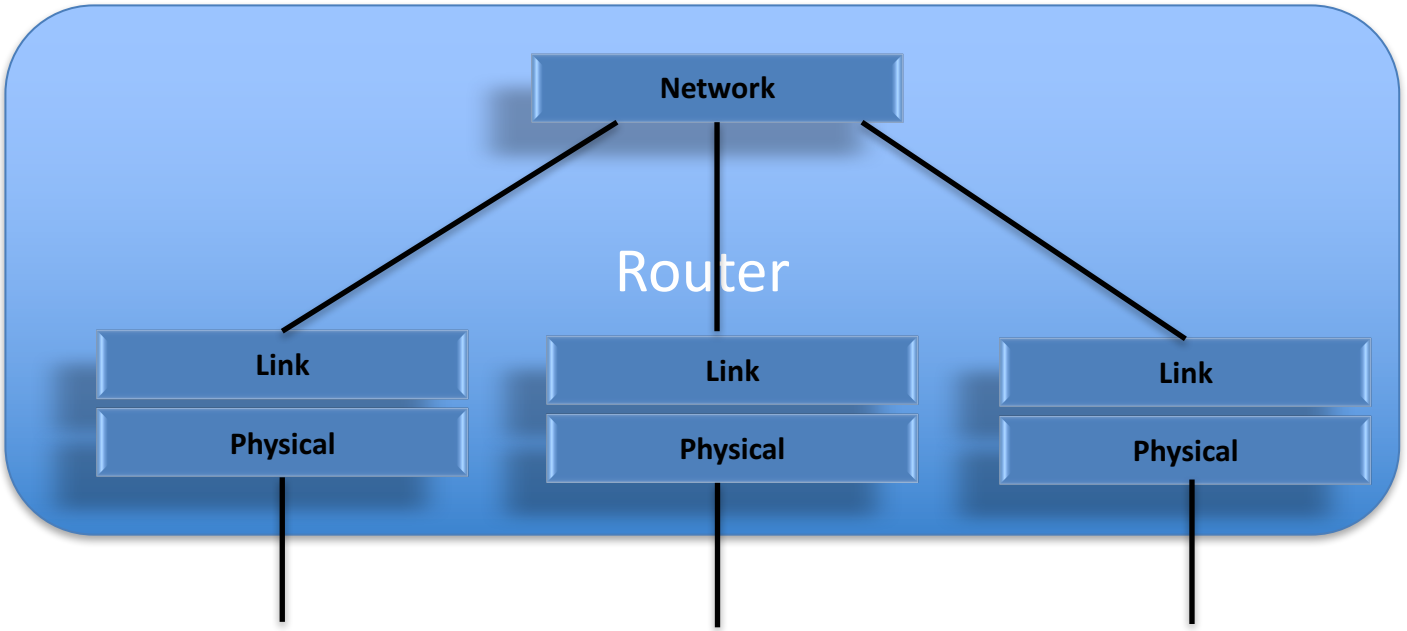
Tutorial 2

(Solutions in red)

Protocol stack

A router, a network devices routing packet at the IP layer (i.e., the network layer of the protocol stack) connects three links. How many of each of the following layers is the router involved with?

- Physical layer
- Data-link layer
- Network layer

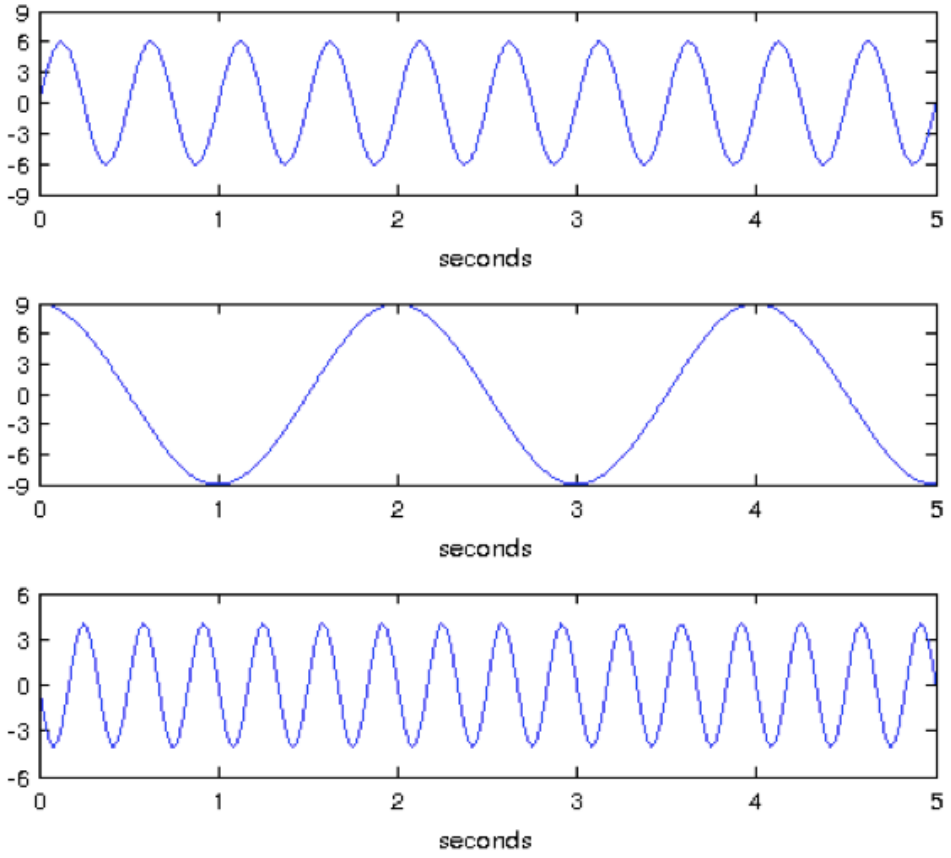


Protocol stack

- Match the following tasks to one or more layers of the TCP/IP protocol stack:
  - route determination; Networking
  - Transmission of signal over transmission media; Physical
  - implementation of a service for the end user; Application
  - management of an end-to-end communication session between two nodes. Transport

Periodic Signals

- Identify the frequency, the period, the peak amplitude and the phase of the three signals in the figure. Write each signal as a function of time, e.g. y = A sin(2πf t + ϕ).



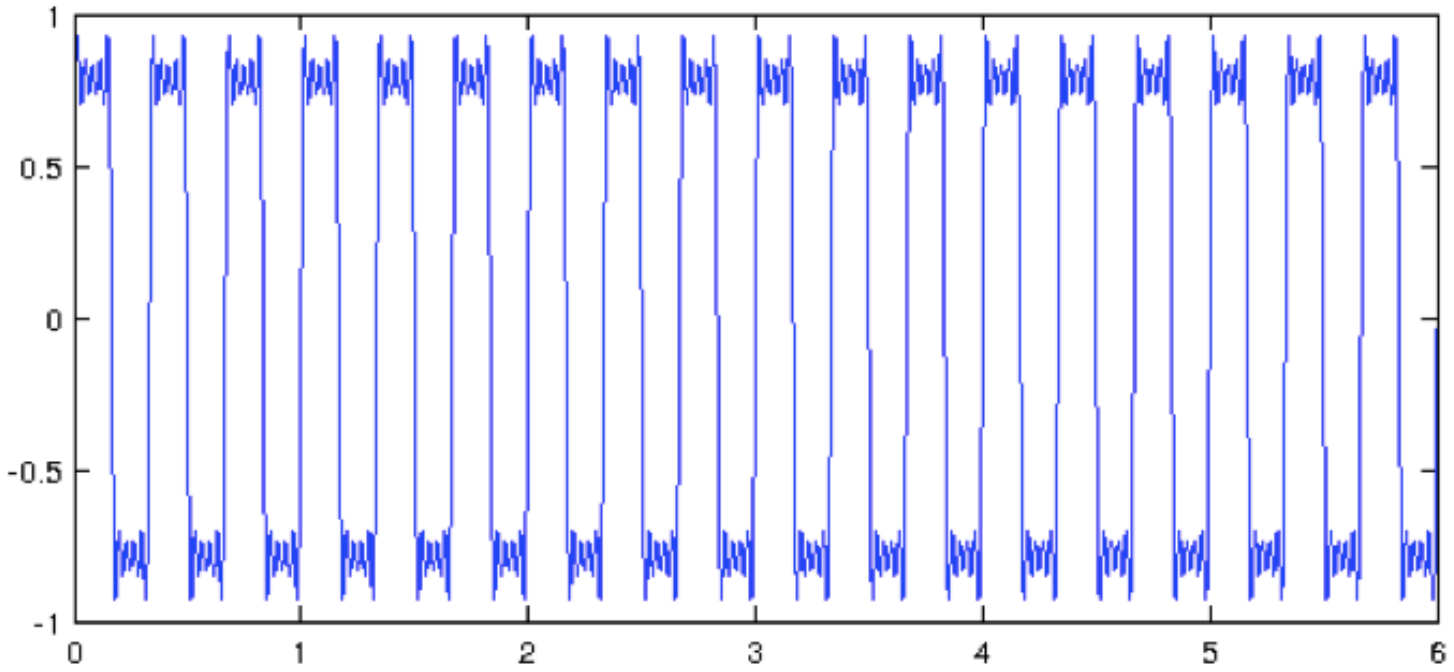
A=6, f=2Hz, T = ½, ϕ=0.
$y = 6\sin(4\pi t)$

A=9, f=0.5Hz, T = 2, ϕ= π/2.
$y = 9\sin(\pi t + \pi/2)$

A=4, f=3Hz, T = 1/3, ϕ= π.
$y = 4\sin(6\pi t + \pi)$

Approximation Through Fourier Series

- In the figure you can see the approximation of a square wave obtained using the first 5 non-zero components of its Fourier series. Recall that the Fourier series of a square wave can be written as $\Sigma 1/n \sin(2\pi nft)$ where n are all odd numbers and f is the frequency of the square wave.
- Write down the sinusoidal components that, when summed, give the signal depicted in the figure and sketch each of their graphs with the correct amplitude and frequency.



Approximation Through Fourier Series

Solution

The frequency of the square wave is f=3. Thus:

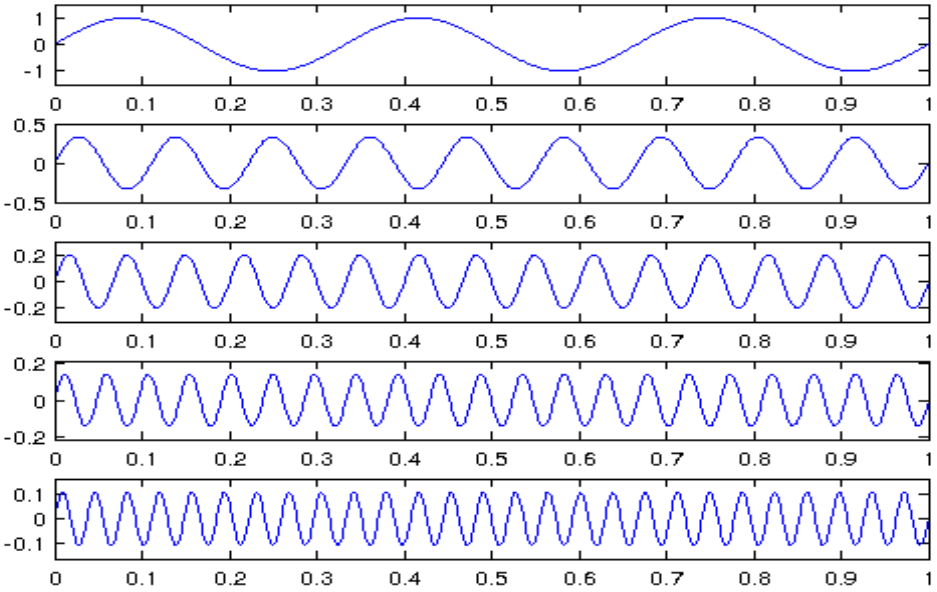
$y1 = 1 \sin(2\pi\ 3t + 0)$

$y3 = 1/3 \sin(2\pi\ 9t + 0)$

$y5 = 1/5 \sin(2\pi\ 15t + 0)$

$y7 = 1/7 \sin(2\pi\ 21t + 0)$

$y9 = 1/9 \sin(2\pi\ 27t + 0)$



Y1+y3+y5+y7+y9 = square wave approx. in previous page

Signal bandwidth

- What is the bandwidth of a signal that can be decomposed into four sine waves of constant amplitude, with frequencies at 80, 110, 140, 170 Hz? Draw the discreet amplitude spectrum of this signal.

The bandwidth is 170-80=90 Hz. It has constant amplitude at the specified frequencies.