1, **Short questions 10 points:** Give the most important reason or answer you can think of for each of the following. Each answer should be 1 or 2 lines. Only one reason or answer please! All questions are 2 points apiece.

- **a) Layers:** Name one advantage of layering. **Simplifies the implementation of complex network communication systems and makes it easier to improve individual layers without changing the whole protocol stack.**

- **b) Layers:** Name any three of the layers in the OSI model together with their position in the stack. 1) **Physical** 2) **Data Link** 3) **Network** 4) **Transport** 5) **Session** 6) **Presentation** 7) **Application**

- **c) Terminology:** Explain either what a POP or what a NAP is. **A POP (Point of Presence) is a data center with networking equipment owned by one ISP. The customers of an ISP connect to one of its POPs. A NAP (Network Access Point) is a data center where many ISPs exchange traffic.**

- **d) Shannon limit:** Given that S is the signal strength and N is the strength of the noise, why is the number of bits you can encode in a symbol proportional to log(1+S/N) and not to S/N? **S/N determines the number of distinct symbols one can use. The number of bits that can be encoded by a symbol is the logarithm in base two of the number of distinct values it can have. For example to encode all possible combination of 3 bits one needs $2^3 = 8$ distinct symbols.**

- **e) Freebie:** Name one ISP. **AOL, MSN, Road Runner, Sprint, Verizon, UUNET, Verio, etc.**
2. **Fourier Analysis:** An input signal’s Fourier analysis has already been done for you. The signal is \( I = \sin(2\pi t) + \frac{1}{3}\sin(6\pi t) + \frac{1}{5}\sin(10\pi t) \). We want to show that just three sine waves comes close to approximating a “nice” shape. To avoid the use of calculators, we have a table above which has the value of sine waves at various angles (in fractions of \( \pi \)).

- (5 points) Using the sine table above, first compute and plot the input sine wave at the 5 moments \( t = 0, \frac{1}{12}, \frac{1}{4}, \frac{5}{12}, \frac{1}{2} \). Please draw the wave approximately on the ruled figure (which has amplitude spacing in units 0.25, and time spaced in units of 1/12 of a second).

- (5 points) Assume the input is passed through a channel whose frequency response is such that all waves of frequency 1 Hz or less are passed through unscaled (and with no phase shift) while all waves of frequency greater than 1 Hz are scaled down to 0. Compute the amplitude of the output at the same 5 times and draw it on the same figure as the input (if you have no time, say what the output wave looks like). **The first component has a frequency of 1 Hz, the other two are above 1 Hz, so they get filtered out.** The output will be \( O = \sin(2\pi t) \)

\[
\begin{array}{c|c|c|c|c|c|c}
\hline
x & \sin(x) & x & \sin(x) & x & \sin(x) & x & \sin(x) \\
\hline
\pi/6 & 0.000 & \pi/3 & -1.000 & \pi/6 & 0.000 & \pi/9 & -1.000 \\
\pi/6 & 0.500 & \pi/4 & 0.866 & \pi/7 & -0.500 & \pi/10 & -0.866 \\
\pi/6 & 0.866 & \pi/5 & 0.500 & \pi/8 & -0.866 & \pi/11 & -0.500 \\
\hline
\end{array}
\]

![Figure 1](image-url)