MONASH UNIVERSITY

School of Computer Science and Software Engineering

CSE3020 Network Technology
Semester 2, 2003

Tutorial 2 - Week 3

Question T2.1 - If the solid curve in Figure 1 represents $\sin(2\pi t)$, what does the dotted curve represent? That is, the dotted curve can be written in the form: $A\sin(2\pi ft+\phi)$; what are A, f and ϕ?

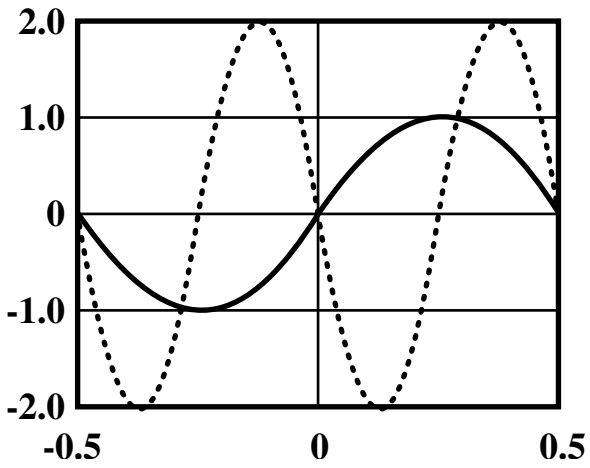


Figure 1: Sine plots for Question T2.1.

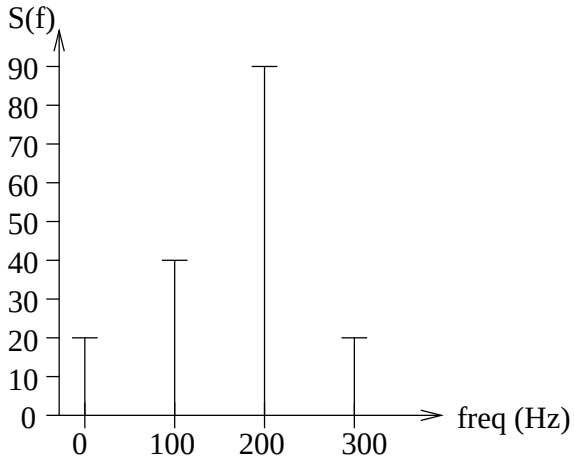
$2\sin(4\pi t+\pi)$; $A=2$, $f=2$, $\phi=\pi$ ←— *This one was prefered.*
OR
$-2\sin(4\pi t)$; $A=-2$, $f=2$, $\phi=0$
OR
$2\sin(-4\pi t)$; $A=2$, $f=-2$, $\phi=0$

Question T2.2 - If given the following signal:

$$s(t)=20+40\sin(200\pi t)+20\sin(600\pi t)+90\sin(400\pi t),$$

plot its amplitude frequency-domain function, $S(f)$. What is the bandwidth of the signal?

Bandwidth = 300 - 0 = 300 Hz.



Question T2.3 - Briefly discuss why a frequency-domain analysis of communications signals is important as compare with a time-domain analysis?

- *An communications signal (or an electromagnetic signal) is made up of many frequencies (and thus a composite signal).*
- *Frequency-domain graph shows the composite signal as a series of component frequencies. It shows the signal as a set of independent frequencies.*
- *Time-domain graph illustrates a composite signal as a single entity. It shows the impact of each component on the others.*
- *The vertical bars of the frequency-domain graph give a more concise view of the relative frequencies and amplitudes of the composite sine waves.*

Question T2.4 - Study the works of Shannon and Nyquist on channel capacity. Each places an upper limit on the bit rate of a channel based on two different approaches. How are the two related.

- *Nyquist analyzed the theoretical capacity of a noiseless channel; therefore that case, the signaling rate is limited solely by the channel bandwidth.*
- *Shannon addressed the question of what signaling rate can be achieved over a channel with a given bandwidth, a given signal power, and in the presence of noise.*
- *Error free channel.*

Question T2.5 - Given a channel with an intended capacity of 50 Mbps, and the bandwidth is 5 MHz. According to Shannon, what signal-to-noise ratio is required to achieve this capacity?

By using Shannon's capacity formula,

$$C = B\log_2(1+S/N) \quad (1)$$
$$50\times10^6 = 5\times10^6\times\log_2(1+S/N) \quad (2)$$
$$\log_2(1+S/N) = 10 \quad (3)$$
$$1+S/N = 1024 \quad (4)$$
$$S/N = 1023 \quad (5)$$
$$SNR_{dB} = 10\log_{10}(1023) = 30.10dB \quad (6)$$

Question T2.6 - A digital system is required to operate at 19,200 bps.

(a) How many signaling levels are required if the channel bandwidth is 1920 Hz?

(b) If a signal element encodes a 6-bit word, what is the minimum required bandwidth of the channel?

By using Nyquist's capacity formula,

(a)

$$C = 2B \log_2 M \quad (7)$$
$$2(1920) \log_2 M = 19,200 \quad (8)$$
$$\log_2 M = 5 \quad (9)$$
$$M = 32 \quad (10)$$

(b)

$$C = 2B \log_2 M \quad (11)$$
$$B = \frac{C}{2 \log_2 M} \quad (12)$$
$$= \frac{19,200}{2 \times 6} \quad (13)$$
$$= 1600Hz \quad (14)$$