Wrocław University of Technology, WPPT 12.03.07

AD HOC SYSTEMS, 2007 Problems, list # 1

1. Express the following in the simplest form You can:

$$sin(2\pi ft - \pi) + sin(2\pi ft + \pi), \;\; sin(2\pi ft) + sin(2\pi ft - \pi)$$

2. Sound may be modeled as sinusoidal functions. Compare the wavelength and relative frequency of musical notes. Use 330 m/s as the approximation of the speed of sound and the following frequencies for the musical scale:

Note	C	D	E	F	G	A	B	C
Frequency	264	297	330	352	396	440	495	528

3. Decompose the signal $(1 + 0.1\cos 5t)\cos 100t$ into linear combination of sinusoidal functions. Find the amplitude frequency, and phase of each component.

4. Given a channel with an intended capacity of 20Mbps the bandwith of the chanel is 3 MHz. What signal-to-noise ratio is required to achieve this capacity?

5. For a radio transmision in free space, signal power is reduced in proportion to the square of the distance from the source, whereas in the wire transmission, the attenuation is a fixed number of dB per kilomiter. For instance, in a distance of 1 km the dB reduction relative to some reference for free space radio is -6 dB, and for uniform wire is -3 dB. Calculate the reduction for other distances (2,4,8,16 km).

6. Derive the equations $d = 3.57\sqrt{h} \;\; d = 3.57(\sqrt{h_1} + \sqrt{h_2})$ for LOS for one and two antennas respectively (Assume that The Earth is a perfect sphere and it's radius is equal to 6370 km).

7. Determine the hight of the TV station's antenna to have a transmitting range of radius 80km.

8. What SNR ratio is required to achieve a bandwith efficiency of 1 for ASK, FSK, PSK and QPSK? Assume that the required bit error rate is 10^{-6}.

9. Consider the angle-modulated signal: $s(t) = 10\cos[2\pi(10^6)t + 0.1\sin(10^3)\pi t]$
   (a) Express $s(t)$ as a PM signal with $n_p = 10$.
   (b) Express $s(t)$ as a FM signal with $n_f = 10\pi$.

10. Let $m_1(t)$ and $m_2(t)$ be message signals and let $s_1(t)$ and $s_2(t)$ be the corresponding modulated signals using a carrier frequency of f_c.
    (a) Show that if simple AM modulation is used, then $m_1(t)+m_2(t)$ produces a modulated signal equal that is a linear combination of $s_1(t)$ and $s_2(t)$. This is why AM is sometimes referred to as linear modulation.
    (b) Show that if simple PM modulation is used, then $m_1(t)+m_2(t)$ produces a modulated signal equal that is not a linear combination of $s_1(t)$ and $s_2(t)$. This is why Angle modulation is sometimes referred to as nonlinear modulation.

/-/ Mirosław Kutyłowski