National University of Singapore
School of Computing

CS2105 **Problem Set 8** Semester 2 05/06

1. It can be shown that the average power of a full-scale sinusoidal signal with amplitude A is $A^2/2$. A current function is given by, i(t) = 5 + 3 sin(50266t) amperes, where t is a time variable in seconds. What is the period of i(t)? What average power results in a 2-ohm transmission line when it passes a current whose function is given by i(t)?

2. Consider a point-to-point link that consists of a transmission line with a cascaded system of two amplifiers in between two stations, X and Y. Given that
   the power loss on the link between X and the first amplifier = 20 dB,
   the power loss on the link between Y and the second amplifier = 10 dB,
   the power loss on the link between the two amplifiers = 8 dB,
   the power gain of the first amplifier = 13 dB, and,
   the maximum power gain of the second amplifier = 20 dB.

   A signal with a power of 5 mW is sent from X to Y. Calculate the signal power at Y in (a) dBW, (b) Watts.

   If Y requires double the power (in Watts) available currently for its operation, what should be the gain of the first amplifier in dB? Assume that power losses on the three links remain the same.

3. In a given transmission system the strength of the signal measured at the sending end is 36 mW. The noise at the receiving end has an average level of 30 mV irrespective of whether there is a signal on the line or not. If the signal attenuation along the line is 1 dB per km, calculate the maximum effective length of the line that can be used before the SNR becomes equal to 20 dB. Assume that the two ends of the line have the same electrical impedance of 10 ohms

4. The time-domain signal function of a triangular waveform is given by

$$s(t) = \begin{cases} \frac{2A}{T}t + A & \text{for } -0.5T < t \le 0, \\ \frac{-2A}{T}t + A & \text{for } 0 < t \le 0.5T, \end{cases}$$

   where A and T are the maximum amplitude and the period of s(t) respectively. Also, it can be shown that the trigonometric Fourier series for the signal is,

$$s(t) = \frac{A}{2} + \sum_{n=1}^{\infty} \frac{2A}{\pi^2 n^2}(1 - \cos n\pi)\cos(2\pi n f t),$$

   where f = 1 / T.

   (a) A low-pass filter is used to retain only the lower-harmonic components of the signal. Calculate the power for each of the first six components (i.e., up to the fifth-harmonic component).

   (b) The output signal noise level measured at the filter is 2.078 mW. If the minimum required output signal to noise ratio is to be maintained at 20 dB, determine how many harmonic components must be accommodated in the output waveform. What are the harmonics? Assume that A is chosen to be 1 Volt and that the electrical impedance at the output is 1 ohm.

   (c) What is the effective bandwidth of the output waveform.

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