COMP90007 Internet Technologies

Week 4 Workshop

Semester 2, 2021

Suggested solutions

Question 1 (Sampling)

- Consider a telephone signal that is bandwidth limited to 4 kHz.

  - (a) At what rate should you sample the signal so that you can completely reconstruct the signal?

    min. sampling rate = 2 ×

  - (b) If each sam~~ple~~ ~~is~~ ~~c~~oded at 256 levels, how many bits are required for e

    256 possible values per sample requires $\log_2(256) = 8$

  - (c) What is the minimum bit rate required to transmit this signal?

    8 bits/sample × 8000 samples/sec = 64 kbps

Note: This is a direct application of the Sampling Theorem and forms the basics of the application of the theorem, i.e. without considering data rates.

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Question 2 (Sampling)

- Is the Sampling theorem true for optical fibre or only for copper wire?

- The Sampling theorem is a property of mathematics and has nothing to do with

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- The Sampling theore
  medium. The Sampling theorem states that
  function which does no contain any frequen

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  (sines or cosines) above *f*, then by sampling
  of *2f*, you capture all the information there is.

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Question 3 (Max Data Rate)

■ Given a noiseless 4 kHz channel, what is the maximum data rate of the communication channel?

• A noiseless channel can carry an arbitrarily large amount of i   e
  an infinite numb https://eduassistpro.github.io/
  because there is no noise. This is
  observation and the level information edu_assist_pro
  restricted by the question in any way. Shannon
  specifies a limit on the information rate based
  on given noise level.

Question 4 (Max Data Rate)

- The bandwidth of a television video stream is 6 MHz. How many bits/sec are sent if four-level digital signals are used? Assume a noiseless channel.

The maximum baud ra
Four levels of signallin
Hence, the total data rate is: 12 M symbols/   ol = 24 Mbps

Question 4 (Max Data Rate)

■ The bandwidth of a television video stream is 6 MHz. How many bits/sec are sent if four-level digital signals are used? Now assume a S/N of 20dB (i.e., 100).

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Using Shannon's theo
= 6MHz x lo

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ps

Using Nyquist's theorem, we have: 2B x $\log_2$

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= 2 * 6MHz x $\log_2$ 4 = 12MHz x 2

The bottleneck is therefore the Nyquist limit, giving a maximum channel capacity of 24Mbps.

Question 5 (Framing)

The following character encoding is used in a data link protocol:

A: `01000111` B: `11100011` FLAG: `01111110` ESC: `11100000`

Show the bit sequence transmitted (in binary) for the four-character frame payload *A B ESC FLAG*, when each of the following framing methods are used:

(a) Character count

(b) Flag bytes with

(c) Starting and ending flag bytes, with

Answer:

1. `00000101` `01000111` `11100011` `11100000` `01111110`
       5   A   B   'ESC'   'FLAG'

2. `01111110` `01000111` `11100011` `11100000` `11100000` `11100000` `01111110` `01111110`
      FLAG   A   B   ESC   'ESC'   ESC   'FLAG'   FLAG

3. `01111110` `01000111` `110100011` `111000000` `011111010` `01111110`
      FLAG   A   B   'ESC'   'FLAG'   FLAG

Question 6 (Framing)

The following data fragment occurs in the middle of a data stream for which the byte-stuffing algorithm as described in the lecture is used:

A B ESC C ESC

What is the output after stuffing

Answer:

After stuffing we get:

A B ESC ESC C ESC ESC ESC FLAG ESC FLAG D.