COMPSCI 314: Exercises

1. Calculate the number of taps necessary to send all 26 letters of the alphabet in Morse code and bits in a code in which each letter has a code of length 5.

2. Calculate the ASCII code for

   HELLO 007!

3. Check that $\{0, 1, 10, 01, 010, 001, 101\}$ is a binary code. Find the shortest encodings that are not uniquely decodable with this code.

4. In transmitting Morse code messages, telegraph operators left a time gap between letters (and a longer gap between words). Why do you think they did this?

5. Can you think of any reasons behind the assignment of particular Morse codewords to particular symbols?

6. What might be the difficulty for a human user in using a prefix code with no time gaps between letters or words to receive telegraph messages?

7. Give an example of a uniquely decodable code which is not a prefix code. Justify your answer.

8. Give an example of a variable length code which is a prefix code. Justify your answer.

9. What is a kibibyte (KiB)? Enumerate multiples of kibibytes (name, symbol and value).

10. What is a YB? And what is a YiB? Which is higher: a YB or a YiB? Justify your answer.

11. The Baudot code is a fix-length code using 5 bits for each character (digits and letters). Since we have 36 letters and digits (plus special characters) to code, do you have a problem? Give a reason in case there is no problem; if there is a problem, indicate the solution.

12. Calculate the Baudot code for

    HELLO 007!

13. Consider the sets of strings: $C_1 = \{1, 110, 1110, 11110\}$ and $C_2 = \{1, 011, 0111, 01111\}$.

    - Is C_1 a code?
    - Is C_2 a code?
    - Is C_1 a prefix-code?
    - Is C_2 a prefix-code?
    - Is C_1 a uniquely decodable?
    - Is C_2 a uniquely decodable?

    Justify each answer.

14. Is ASCII a prefix code? Justify your answer.

15. Construct a prefix binary code for which the codewords lengths are exactly: 12, 2, 7.

16. Can you construct a prefix binary code for which the codewords lengths are exactly: 2, 1, 2, 133333? Justify your answer.

17. Is the set of strings $C = \{1, 011, 0111, 01111, 011111\}$ code? Is C a prefix code? Is C uniquely decodable? Construct a prefix code for which the codewords lengths are exactly the lengths of the codewords in C.

18. A sine function can be written in the form:

$$s(t) = A\sin(2\pi ft + k).$$

    Explain the meaning of t, A, f and k.

19. Present two applications of the Fourier transform.

20. Define the bit rate and baud rate and the relation between them.

21. What is the signal-to-noise ratio (S/N)? How do we measure S/N? What is the relation between bite rate and S/N in a noisy transmission?

22. A telephone has a bandwidth of about 3,000 Hz and a signal-to-noise of approximately 35 dB. What is the capacity of the telephone channel in bits per second?

23. Describe two methods of converting a digital signal into an analog one.

24. What is PAM ? What is PCM?

25. A TV screen displays about 30 pictures (frames) per second. Each picture consists of approximately 200,000 pixels, each with different intensities of the primary colours of blues, green, and red. Finally, 8 bits represent each of the primary colours of one pixel.

    - How many bits do you need for representing a picture?
    - If an hour movie has about 108,000 different pictures, then how many bits do we need to represent it?

26. Assume that you wish to email a large file consisting entirely of strings of lower-case letters (26), plus the digits 0,1,2,3,4,5,6,7. If the file has n characters each stored as an 8-bit ASCII code, then we need $8n$ bits. Can you do it better? Present your solution and calculate the size of the compressed file. How much size reduction have you obtained?

27. Devise two correct Huffman trees and their corresponding codewords for letters whose frequency of occurrence is in the following table:

Letter	Frequency
A	15%
B	15%
C	10%
D	10%
E	20%
F	10%
G	10 %
H	10 %

    Encode the string AFDEEGH using both Huffman trees constructed.

28. Describe the general encoding scheme of JPEG.

29. Describe the general encoding of MP3.

30. Describe two copy protection technologies.

31. Describe with an example the parity bit method of checking data integrity.

32. Describe with an example the two-dimensional parity bit method of checking data integrity.

33. Calculate the number of redundancy bits r required to correct n bits of data. Apply your result for the case $n = 15$.

34. Use the Hamming code to calculate the codeword for 10011010. Explain each stage in your calculation.

35. Use the Hamming code to calculate the codeword for 10011010. Assume that instead of 011100101010 the receiver got 011100101110. Show how the receiver can calculate which bit was wrong and correct it.

36. Test if codeword 010101100011 is correct, assuming it was created using an even parity Hamming code. If it is incorrect, indicate what the correct codeword should have been. Finally, indicate what the original data was.

37. What is the Hamming distance? Calculate the Hamming distance between the codewords 010101100011 111110001100. Indicate an application of the Hamming distance in error-correction.

38. Indicate three reasons for Skype success in VoIP.

39. In what sense Skype is self-modifiable?

40. Discuss some limitations of Skype.

41. What is a permutation code for a five-letter alphabet? How can we use a permutation code to correct errors? What is its limit?