



**Exercise I: Multiple choice [30 pts]**

1. A still image has the following form(s) of statistical redundancy
  - a. Spatial redundancy.
  - b. Spatial as well as temporal redundancy.
  - c. Temporal redundancy.
  - d. Neither spatial nor temporal redundancy.
2. A still image with uniform intensity exhibits
  - a. Best spatial redundancy.
  - b. Worst spatial redundancy.
  - c. Best temporal redundancy.
  - d. Worst temporal redundancy.
3. A quantizer at the encoder performs:
  - a. One-to-one mapping.
  - b. One-to-many mapping.
  - c. Many-to-one mapping.
  - d. Many-to-many mapping.
4. The entropy of a source of symbols is dependent upon:
  - a. The number of source outputs generated.
  - b. The average codeword length.
  - c. The probabilities of the source symbols.
  - d. The order in which the source outputs are generated.
5. Which one of the following is not true for Huffman coding?
  - a. No codeword of an elementary symbol is a prefix of another elementary symbol.
  - b. Each symbol has a one-to-one mapping with its corresponding codeword.
  - c. The symbols are encoded as a group, rather than encoding one symbol at a time.
  - d. Shorter code words are assigned to more probable symbols.
6. A source of 4 symbols  $a_1, a_2, a_3, a_4$  having probabilities  $P(a_1)=0.5, P(a_2) = 0.25, P(a_3)=P(a_4)=0.125$  is used for arithmetic coding. The source symbol sequence  $a_2a_1$  will correspond to the interval (mark the closest answer):
  - a.  $[0.25, 0.375)$
  - b.  $[0.5, 0.625)$
  - c.  $[0.75, 0.875)$
  - d.  $[0,1)$
7. M-JPEG is a video compression technique that uses:
  - a. Spatial redundancy
  - b. Spatial as well as temporal redundancy
  - c. Temporal redundancy
  - d. Neither spatial nor temporal redundancy

8. Given the below DCT coefficients of an image in the table on the right, reading them in zig-zag order produces the following sequence :

- a. 118, 42, 54, 150, 42, 32, 30, 34, 100, 60, 43, 98, 44, 39, 40, 31
- b. 118, 42, 100, 44, 42, 32, 60, 39, 54, 30, 43, 40, 150, 34, 98, 31
- c. 118, 42, 42, 54, 32, 100, 44, 60, 30, 150, 34, 43, 39, 40, 98, 31
- d. 118, 42, 42, 100, 32, 54, 150, 30, 60, 44, 39, 43, 34, 98, 40, 31

118	42	54	150
42	32	30	34
100	60	43	98
44	39	40	31

9. What is the number of colors that may be stored in a pixel that has a color depth of 10?

- a. 256
- b. 512
- c. 768
- d. 1024

10. JPG compression analyzes images in blocks of \_\_\_\_\_ pixels in size and selectively reduces the detail within each block

- a. 6 x 6
- b. 8 x 8
- c. 16 x 16
- d. 32 x 32

### Exercise II: True / False [15 pts]

For each of the following questions, answer with true or false.

1. JPEG2000 compression bases on the DCT transformation.
2. Coding large image/file size using LZW leads to poorer compression.
3. The sequential search of motion vectors is faster than hierarchical search.
4. I frames are inserted as access point frames.
5. VOP stands for Video Object Plane.
6. RLE is a probabilistic compression technique.
7. DPCM stands for differential point coding modulation.
8. RGB colors space is the suitable colors space for image processing and analysis.
9. A P frame can be obtained from I, P or B frames
10. B Frame is used in all the video compression standards today.

### Exercise III: Motion Vectors [35 pts]

Consider the following piece of two consecutive frames. Suppose now that we want to search sequentially for the highlighted block of the frame n+1 in the whole frame n. Answer the following questions:

- a. For each block in frame n+1, how many MAD calculations should be done?
- b. Deduce the total number of MAD calculations to be done in order to calculate the motion vector for all the 2x2 blocks in frame n+1.
- c. If each 2x2 MAD calculation takes 1 ns, what is the time needed to predict all the motion vectors of all the blocks in the frame n+1?

- d. Answer the parts a, b, and c if we consider a logarithmic search instead of sequential search.

139	144	149	153	155	155	155	155
144	151	153	156	159	156	156	156
150	155	160	163	158	156	156	156
159	161	162	160	160	159	159	159
159	160	161	162	162	155	155	155
161	161	161	161	160	157	157	157
161	162	161	163	162	157	157	157
162	162	161	161	163	158	158	158

frame  $n$

155	155	139	144	149	153	155	155
156	156	144	151	153	156	159	156
156	156	150	155	160	163	158	156
159	159	159	161	162	160	160	159
155	155	159	160	161	162	162	155
157	157	161	161	161	161	160	157
157	157	161	162	161	163	162	157
158	158	162	162	161	161	163	158

frame  $n+1$

#### Exercise IV: Compression [20 pts]

Suppose having the source with the alphabet  $S = \{A, B, C, D, E\}$  and the following probabilities  $\{0.1, 0.2, 0.4, 0.2, 0.1\}$ .

- Encode the following sequence of symbols CBCE.
- What is the average bits per symbol of the encoding process.