

CMPT 365 Midterm Examination Spring 2006

(Please answer all questions for a total of 100 points)

1. (30 points) [Short Answer Questions]

- (a) (7 points) Name at least three factors that affect the quality of *digital audio*.
- (b) (7 points) What is *S-video*? Why is it better than *Composite video*?
- (c) (8 points) What is the color of (1, 0, 1) in the CMY Cube? What do the two 1's and one 0 indicate here?
- (d) (8 points) It is known that musical note A-4 (the A-note at the 4th octave) has a fundamental frequency of 440 Hz. Which *harmonic* of it has the same frequency as the fundamental frequency of A-7, why?

2. (20 points) [GIF Images]

GIF images can only have up to 256 colors.

- (a) Briefly describe one color quantization (reduction) method that will convert a 24-bit color image into a GIF image.
- (b) Give one example to illustrate how the color look-up table is used in displaying GIF images.

3. (25 points) [Lossless Compression]

- (a) Entropy of an information source is defined as

$$\eta = \sum_i p_i \log_2 \frac{1}{p_i}$$

Suppose an 8-bit “checker-board” image has a resolution of 256×256 , and half of its pixels are White and half of them are Black.

- (i) What is the entropy of the image? (ii) What does it mean?
- (b) Do *Huffman Coding* for a set of symbols $S = \{a, b, c, d, e\}$, where $p_a = 0.3$, $p_b = 0.25$, $p_c = p_d = p_e = 0.15$.

Hint: You do not need to describe the algorithm. Simply show how you build the trees **step by step** and the resulting codewords.

4. (25 points) [Chroma subsampling]

(a) It is known that JPEG and MPEG use *Chroma Subsampling*.

(i) What is the purpose of the chroma subsampling? (ii) Why is it feasible?

(b) Given the color image as shown below

<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>
<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>
<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>
<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>
<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>
<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>	<i>W</i>
<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>
<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>

show the image resolutions and all pixel values of the YUV images after the 4:1:1 chroma subsampling.

Hint: (a) You may assume $W = (1, 1, 1)$ and $B = (0, 0, 1)$ in the RGB color model. (b) If the YUV and RGB images are of the same resolution, then

$$\begin{bmatrix} Y \\ U \\ V \end{bmatrix} = \begin{bmatrix} 0.3 & 0.6 & 0.1 \\ -0.3 & -0.6 & 0.9 \\ 0.7 & -0.6 & -0.1 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$