

## **Problem 1: Binary, Decimal, and Hex Number Representations**

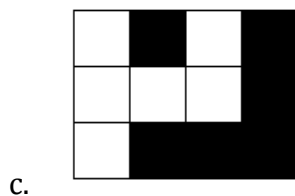
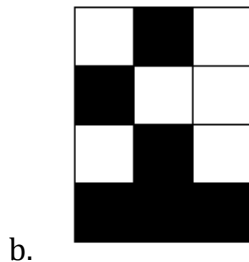
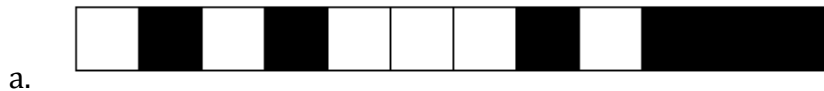
### **[6 marks]**

A conversion table is provided at the end of this exam, you can pull it off and use it for this question.

1. [1 mark] Convert the following binary number into hex: 1 1111 0000 1011
2. [1 mark] Convert the following hex number into decimal: 1CF
3. [1 mark] Convert the following decimal number into binary: 201
4. [1 mark] What is the complement of 1110 0110?
5. [1 mark] What is the sum (in binary) of the following two binary numbers?  
0001 1111 + 0011 1000
6. [1 mark] In a binary, or base-2, system, each bit, or digit, is either 0 or 1, and we can represent the eight decimal numbers from 0 to 7 using three-bit binary numbers. Consider instead a ternary, or base-3, system in which each digit is 0, 1, or 2. How many decimal numbers can be represented using three-digit ternary numbers?

## Problem 2: Image Representation [7 marks]

1. [1 mark] What are the three colours that make up all colours that you see on monitors and TV screens?
  - a. Red, Blue, Yellow
  - b. Red, Green, Blue
  - c. Red, Yellow, Blue
  - d. Yellow, Green, Blue
  
2. [1 mark] Suppose I had a colour (#456545) and then I changed it to (#006500). What happened to the colour?
  - a. It stayed the same
  - b. It changed into a different colour
  - c. It got lighter
  - d. It got darker
  
3. [1 mark] Given the following bitmap image representation (following the conventions described in the lectures), which is the correct image?  
3x4  
FFFFFF 000000 FFFFFFFF 000000 FFFFFFFF FFFFFFFF FFFFFFFF 000000 FFFFFFFF  
000000 000000 000000



4. [2 marks] Give **two** situations where vector representation of data might be a better choice than bitmap representation.

5. [1 mark] If I have a 2D image that has a large file size and becomes pixelated when I zoom in, is it more likely to be a bitmap image or vector image representation? Circle your answer.

Bitmap

Vector

6. [1 mark] In run-length-encoding, “runs” of identical colour intensities in a bitmap image representation are collapsed. Is this a lossless or lossy image compression technique? Circle your answer.

Lossless

Lossy



### Problem 4: Decision Tree [8 marks]

1. [3 marks] Draw a binary tree with a depth of 3 and with 5 leaves. You do not need to label nodes and edges.

2. Abby is trying to decide whether she will go skiing today or not.

Homework Load	Number of People in Line	Weather	Ski?
Low	Minimal	Very Cold	Yes
Medium	Minimal	Warm	No
Medium	High	Very Cold	Yes
Low	Minimal	Cold	Yes
High	High	Cold	No
High	Minimal	Cold	Yes

[3 marks] According to the definition of entropy that we used in class, what is the entropy if you split on:

- Homework Load?
- Number of People in Line?
- Weather?

[1 mark] What attribute should you split on first to reduce entropy?

[1 mark] Draw the decision tree that starts splitting from the attribute you identified above.

### Problem 5: Clustering [5 marks]

1. [1 mark] Which of the following algorithms lists the steps of the k-means algorithm for clustering a set of points? Circle your answer.
  - a. **Algorithm A**
    - i. Choose k centroids at random to act as the “centre” of your clusters
    - ii. For each point, determine which of the k centroids it is farthest from and assign the point to the cluster associated with that furthest centroid
    - iii. Average the points inside each of the k clusters to get k new centroids
    - iv. Repeat steps ii and iii as many times as you would like or until the answer stabilizes
  - b. **Algorithm B**
    - i. Choose k centroids at random to act as the “centre” of your clusters
    - ii. Count all the points and distribute them as evenly as possible to the k centroids, to form k roughly evenly-sized clusters
    - iii. Take the median of the points inside each of the k clusters to get k new centroids
    - iv. Repeat steps ii and iii as many times as you would like or until the answer stabilizes
  - c. **Algorithm C**
    - i. Choose k centroids at random to act as the “centre” of your clusters
    - ii. For each point, determine which of the k centroids it is closest to and assign this point to the cluster associated with that closest centroid
    - iii. Average the points inside each of the k clusters to get k new centroids
    - iv. Repeat steps ii and iii as many times as you would like or until the answer stabilizes
  - d. **Algorithm D**
    - i. Choose k centroids at random to act as the “centre” of your clusters
    - ii. Count all the points and distribute them as evenly as possible to the k centroids, to form k roughly evenly-sized clusters
    - iii. Average the points inside each of the k clusters to get k new centroids
    - iv. Repeat steps ii and iii as many times as you would like or until the answer stabilizes

