Quiz 8 (Nov 20, 2025)

Name: ANSWERS NetID (e.g., ap191):

Please write your answers **clearly** and **keep them brief**.

Problem	Score
Question 1	/ 5
Question 2	/ 5
Total	/ 10

Instructions

For all questions in this quiz, please assume:

a. Each disk block is 4KB in size.

b. The superblock and all blocks associated with the root directory (`/`) are in the buffer cache. No other blocks are in the buffer cache.

c. No other blocks are in the buffer cache.

d. The buffer cache is sufficiently large to hold any blocks that are read.

e. For any directory (including the root directory), all of the `dirents` it contains occupy less than 4KB.

f. Each inode has 4 direct pointers and 1 indirect pointer. The indirect block (that the inode's indirect pointer might point to) can hold up to 32 pointers.

Questions

1. For each of the following accesses, state the total number of blocks **read from the disk**:

   (i) Reading all of the contents of the file `/home/aturing/tm.txt`. The file contents occupy 5KB. [2.5 points]

   Two directories need to be read (`home`, `aturing`). Each requires 2 accesses (1 each for the inode and data block): **4 blocks**
   `tm.txt`'s inode: **1 block**
   5KB requires 2 data blocks: **2 blocks**

   Total: **4 + 1 + 2 = 7 blocks**

   (ii) Reading all of the contents of the file `/home/achurch/lcalc.txt`. The file contents occupy 32KB. [2.5 points]

   Two directories (same as above): **4 blocks**
   Data blocks: **8 blocks =** $\frac{32}{4}$
   Inode (Points to 4 data blocks): **1 block**
   Indirect block (Remaining 4 data blocks): **1 block**

   Total: **4 + 8 + 1 + 1 = 14 blocks**

2. Let us make sure that allocating in a way that improves locality is useful. For this question, consider a disk with the following characteristics:

Rate of rotation	3000 RPM (or 50 rotations per second)
Average seek time	100ms = 0.1s
Transfer time	10×4KB/s $= 10$ blocks/second

Furthermore, assume that a cylinder group consists of all blocks in **one cylinder**. (For this question, we will give partial credit for stating how you arrived at the numbers. You also do not need to finish the arithmetic, it is fine to leave equations such $x + n \times y$ where n, x and y are numbers.)

(i) How much time does it take to read 20 blocks placed in the same cylinder group? Assume that they are randomly spread across the cylinder group. [2.5 points]

Seek to the cylinder group: 0.1s

Access for each block: rotation (average = $\frac{\frac{1}{50}}{2} = 0.01$s) + transfer time ($\frac{1}{10}s$) = $.01 + 0.1 = 0.11$s

Total: $0.1 + 20 \times 0.11 = 2.3$s

(ii) How much time does it take to read 20 blocks distributed randomly across all cylinder groups on the disk. [2.5 points]

Access for each block: seek + rotation + transfer time = 0.21s

Total: $20 \times 0.21 = 4.2$s