Exercise 3: RAID & Pages & Buffer management

Task 1: RAID Systems

a) Which RAID-level exist/are discussed in the lecture? How are these levels differentiable from each other. Are there other levels that were not introduced in the lecture (Investigation/Research!).

b) Which RAID-levels are suitable for DBS and which are not?

c) On a RAID-3 system with 5 disks the following records are stored:
   1. Disk \( \text{D1} = 10100101 \)
   2. Disk \( \text{D2} = 11110000 \)
   3. Disk \( \text{D3} = 00111100 \)
   4. Disk \( \text{D4} = 10111001 \)

   Explain a procedure for the computation of the parity bit \( P \). Assume, that disk No. 3 is defective. How can \( \text{D3} \) be computed from the remaining information?

Task 2: Hard Disks vs. Flash Storage

a) Discuss the advantages and disadvantages of mag tapes, main memory, hard disks and flash storage for the storage of data in databases. Put the focus particularly on size, speed (read, write, sequential, randomized), costs (purchase, operational), reliability and durability (lifetime) and investigate current values.

b) Give a hard-disk with blocks of 512 Byte each and the following parameters: Reading with 40 MB/s; Writing with 30 MB/s; Access time: 15 ms

   Furthermore, a NAND-Flash medium is given, which is divided into blocks of 128 KB, where each block is partitioned in 64 pages respectively. The parameters are as followed: 25 \( \mu \)s for starting a read operation; 100 \( \mu \)s for reading a page; 2 ms for deleting one block; 200 \( \mu \)s for writing a page.

   How long last the following operations:
   1. Sequential read of 1 GB (or 1 TB),
   2. Reading of 1 GB (or 1 TB), where all data are distributed (random) to data blocks of 4 KB each,
   3. Writing of 10 MB (sequential),
   4. Writing of 1 Byte.

c) Which opportunities result from flash storage for databases? Which current developments can be discovered (in the market)?

Task 3: Buffer Management

a) For what is a buffer management hosted in databases?

b) Which page replace strategies exist (Investigation!)? What are (dis-)advantages?
c) Given a DBMS with buffer size of 5 pages. The pages a, b, c, d, e, f, g are read in the following order during a transaction:
   a, b, b, b, b, c, e, g, f, d, b, e, b, f, e, a, g, a, b, c, a, d, f, b, b, f, f, e, b, e, g
   Compute the number of page replaces for these strategies (see b)).

d) Why DBMS have their own buffer management, although the OS already has one?