

1. This is a closed book examination; a handwritten study sheet is allowed.
2. Please check the entire examination immediately to ensure that your copy has all seven pages.
3. Put your name on all pages of the examination.
4. All questions have equal mark value.
5. Neatness counts.
6. You must clearly show your work; take time to prepare a legible answer.
7. There will be no regrades on examinations written in pencil.
8. Good luck and have fun!

name _____

student id _____

email address _____

1. _____ 5. _____

2. _____ 6. _____

3. _____ 7. _____

4. _____ total _____

1.a What benefits are derived from using RAID data layouts?

1.b What disadvantages are there to using RAID data layouts?

1.c At the time the RAID scheme was popularized to meet client needs, there were other varieties of drives available for the client! What were the principal architectural distinguishing features of these other “competing” disk drives?

2.a Show the Prime data layout for $n = 7$ disks with stripe width $k = 3$ for strides one and two. Use the notation A0, A1, PA for the first stripe, B0, B1, PB for the second etc.

2.b Verify the Prime data layout evenly distributes the incremental workload over the surviving disks in degraded mode. You may do this by showing that each pair of disks appears in $k(k - 1)$ stripes within the $k(n - 1)$ rows of the layout.

- 3.a A sorted summary file contains 75 byte summary records as well as a 150 byte header. The header is positioned at the beginning of the file and the summary records are positioned immediately following the header. Here is a list of the summary records –

A A A B B C C D D E E F G H H I I I I J J K K L M N O P P P S T T W

Build an order 3 B+tree index for the file using bottom-up construction. You don't have to adjust the right edge of the tree to assure each node has at least two children; you are to write the nodes into the index file in postorder. You are to assume the summary records are read into a buffer that contains up to three records. Label each pointer with its offset value as well as specifying the root offset. Keep the index file as small as possible.

4. What are the possible phases of a seek operation?

A disk drive has the operational parameters – 15,000 rpm, 300 sectors per track, and 4.1 ms average seek time.

5.a What is the average service time for an 8KB read operation on a single disk? Mark the various service time components within the calculation.

5.b When a single disk has more than a single read operation to service, why can the average service time be smaller than calculated above.

6. An array of 16 disks consists of five groups of stripe width three plus one spare disk. The data layout uses a PDDL scheme. The repair rate is very rapid for the first failure $\hat{\mu}$ when data is reconstructed within spare space. In the degraded mode, reconstruction is much slower μ awaiting a disk swap. The disk failure rate is λ . Specify a Markov reliability model for the array.

7.a A disk array with a declustered data layout contains n disks with stripe width k . The workload of R small reads per second is evenly distributed over the n disks. Assume one disk fails. What is the workload on *each* of the surviving disks if the workload $R \text{ sec}^{-1}$ continues to be satisfied?

7.b What does this imply regarding usage in the fault free mode?