(Last) Surname: _____ (First) Given name: _____

NetID (email): _____ @wisc.edu

Fill in these fields (left to right) on the scantron form (use #2 pencil):
1. LAST NAME (surname) and FIRST NAME (given name), fill in bubbles
2. IDENTIFICATION NUMBER is your Campus ID number, fill in bubbles
3. Under **F** of SPECIAL CODES, write **1** and fill in bubble **1**

If you miss step 3 above (or do it wrong), the system may not grade you against the correct answer key, and your grade will be no better than if you were to randomly guess on each question. So don't forget and double check it's correct!

You may only reference your note sheet. You may not use books, calculators, or other electronic devices during this exam. You may not sit near your friends or look at your neighbors during this exam. Please place your student ID face up on your desk. Turn off and put away portable electronics (including smart watches) now.

Use a #2 pencil to mark all answers. DO NOT USE PEN on the scantron.

When you're done, please hand in the exam and note sheet and your filled-in scantron form. The note sheet will not be returned.

(Blank Page)

1. Which of the following operators enables us to redirect both `stdout` and `stderr` to some file?

   A. `>`   B. `&>`   C. `|`   D. `&`   E. `<`

2. Which of the following `docker run` command flags is used to specify network port information?

   A. `-d`   B. `-e`   C. `-m`   D. `-p`   E. `-v`

3. Parquet is a _____ format, making it most suited for _____ access pattern.

   A. column-oriented, analytics

   B. column-oriented, transactional

   C. row-oriented, analytics

   D. row-oriented, transactional

4. Which of the following commands will take us to the home directory?

   A. `cd .`   B. `cd ..`   C. `cd +`   D. `cd ~`

5. Which SQL clause enables us to perform selection?

   A. `SELECT`   B. `FROM`   C. `WHERE`   D. `GROUP BY`   E. `HAVING`

6. Consider the following code:

```
# thread 1:
r = 0               #A
if q != 0:          #B
    lock.acquire()  #C
    r = 1/q         #D
    lock.release()  #E
print(q)            #F
print(r)            #G


# thread 2:
print(q)        #P
lock.acquire()  #Q
q = 0           #R
lock.release()  #S
```

   Assume q is 5 before the threads start running. Which line of code must be moved into the critical section to ensure that we don't encounter a ZeroDivisionError?

   A. A   B. B   C. F   D. G   E. P

7. Which of the following database guarantees ensures that "all or nothing happens"?

   A. atomiticy   B. consistency   C. isolation   D. durability

8. For a FIFO cache size of 3, what is the hit rate for the below access pattern? Assume that cache is empty prior to the below access pattern.

   `A, B, C, A, B`

   A. 0   B. 0.2   C. 0.4   D. 0.6   E. 1

9. Given below are the schemas of two SQL tables `students` and `grades`:

   `| student_id | student_name | major |`

   `| student_id | course | grade |`

   Which of the following SQL queries answers this question: "What grade did each student secure for their enrolled courses?"

   A. `SELECT students.student_name, grades.course, grades.grade FROM students INNER JOIN grades ON student_id = student_id;`
   B. `SELECT student_name, course, grade FROM students;`
   C. `SELECT student_name, course, grade FROM students INNER JOIN grades ON students.student_id = grades.student_id;`
   D. `SELECT student_name, course, grade FROM grades;`
   E. `SELECT student_name, course, grade FROM students GROUP BY student_name;`

10. In a `Dockerfile`, which of the following will enable us to execute a `python3` program?

    A. FROM   B. RUN   C. COPY   D. CMD

11. Which of the following methods enables us to run a thread?

    A. `join`   B. `acquire`   C. `release`   D. `start`

12. Given below are the schemas of two SQL tables `students` and `grades`:

    | student_id | student_name | major |

    | student_id | course | grade |

    What does the following SQL query produce?

    ```sql
    SELECT student_name, AVG(grade)
    FROM grades
    INNER JOIN students on grades.student_id = students.student_id
    GROUP BY student_name;
    ```

    A. computes average grade for all students in the database

    B. computes average grade for each student across all of their courses

    C. computes average grade for each course

    D. computes count of grades for each student across all of their courses

13. If a client reads 3 MB from a 4x replicated HDFS file, how much data do we read from hard drives?

    A. 3 MB   B. 6 MB   C. 9 MB   D. 12 MB

14. Which of the following file types enables you to create a cluster of docker containers (aka cooperating containers)?

    A. `csv`   B. `parquet`   C. `proto`   D. `yml`

15. Suppose you have the below access pattern for an LRU cache size of 3. Which page will be evicted for placing D into the cache?

    A, B, C, A, B, E, D

    A. A   B. B   C. C   D. E

16. Consider the following code:

    ```
    y = f(x)
    y.backward()
    ```

    Currently, `x.grad` is 3. If you are trying to maximize y, what should you do?

    A. increase x   B. decrease x

17. What does PVM execute?

    A. `machine code`   B. `bytecode`   C. `Python source code`   D. `Java source code`

18. Which of the following is byte addressable?

    A. HDD   B. RAM   C. CPU   D. NIC   E. SSD

19. When you buy a new computing machine and connect it to your existing computing machine to increase your computing capacity, you are scaling _____?

    A. `left`   B. `right`   C. `up`   D. `down`   E. `out`

20. Which of the following docker commands will run a program inside an exsiting container?

    A. `docker stats`

    B. `docker run`

    C. `docker ps`

    D. `docker images`

    E. `docker exec`

21. When scheduler stops running one thread and starts running another, it is called a _____?

    A. critical section

    B. context switch

    C. bytecode-level interleaving

    D. locking

    E. collision resolution

22. A 20x5 PyTorch tensor takes 800 bytes to hold floats (not counting the overhead of the Python object). What kind of floats are these?

    A. float2

    B. float8

    C. float16

    D. single precision float

    E. double precision float

23. HDFS has a boss/worker architecture. What are the specific names given to the boss and workers in HDFS cluster?

        A. namenode, dfsadmin

        B. dfsadmin, namenode

        C. dfsadmin, datanode

        D. datanode, namenode

        E. namenode, datanode

24. Which of the following commands enables us to identify which process is using a particular port?

A. `mount`   B. `head`   C. `lsof`   D. `grep`   E. `docker`

25. Suppose you are running `jupyterlab` inside your Docker container that you started with `docker run -p 127.0.0.1:4000:5000 <SOMEIMAGE>`. If you want `http://localhost:3000/` on your laptop browser to connect to the jupyterlab, what should your `-L` option be for establishing the ssh tunnel?

        A. localhost:3000:localhost:3000

        B. localhost:3000:localhost:4000

        C. localhost:3000:localhost:5000

        D. localhost:4000:localhost:4000

        E. localhost:4000:localhost:5000

(Blank Page)