Universiteit Antwerpen

Name: …………………………………………………………………

OPMERKINGEN

- Begin met het schrijven van je naam op elke pagina én kladblad.
- Dit is een gesloten boek examen.
- Zorg dat je mobiele telefoon uit staat en leg het vooraan in het lokaal.
- Wees zo compleet mogelijk in je antwoorden. Motiveer duidelijk waarom je dit antwoord geeft. **Meestal zijn antwoorden in 1 zin niet voldoende!**
- Alle vormen van communicatie zijn verboden.

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- Start by writing your name on each page and the additional pages
- This is a closed book exam.
- Make sure your mobile phone is switched off and place it at the front of the room.
- Be as complete as possible in your answers. Motivate clearly why you provide this answer. **Usually answers in 1 sentence are not enough!**
- All forms of communication are prohibited.

QUESTION 1: DISTRIBUTED SYSTEMS

A) Describe the two types of coupled logical architectures that a distributed system may follow. Indicate the strengths and weaknesses of each of these types.

QUESTION 2: MIDDLEWARE

A) Indicate the main differences between Local Method Invocation and Remote Method Invocations from the point of view of the used reference, the access and the number of invocations that are required by the client machine (invoker).

B) Indicate what is the role of the Proxy on the Remote Method Invocation process. Indicate how the Proxy and the Skeleton are related.

QUESTION 3: SERVICE-ORIENTED ARCHITECTURES / CLOUD COMPUTING

A) Indicate the difference between the different types of multi-tenancy.

B) List and describe the three service models commonly used in cloud computing.
   - Provide an example of a service following each of the three models.

QUESTION 4: WEB SERVICES

A) REST architectures are characterized by several architectural constraints. Explain each of the following constraints and indicate why each of them is desirable.
   a) Client-server model, b) Caching and c) Layering

B) Describe five ways in which REST resources are described from the point of view of REST URI design.

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QUESTION 5: MICROSERVICES

A) The Reactive Manifesto is characterized by four architectural traits.
   Describe each of these traits and indicate their importance.

B) Indicate why containers are considered a preferable solution over virtual machines (VM) for the implementations of microservices. Indicate at least one advantages and one disadvantage of using containers.

QUESTION 6: DISTRIBUTED STORAGE

A) Directed Acyclic Graphs (DAGs) have been proposed as a good structure to handle disrtibuted storage and processing. Indicate how these DAG structures are defined in the context of disrtibuted storage and processing and what are the advantages of following this type of structure.

B) Indicate the main difference between Narrow and Wide transformation in Resilient Distributed Datasets (RDDs). DataFrames.

QUESTION 7: COORDINATION

A) Describe the Ricart-Agrawala algorithm and indicate how it compares with respect to the Ring-based algorithm.

B) Describe the Garcia-Molina (Bully) algorithm and indicate how it compares with respect to the Chang-Roberts Ring-based algorithm.

QUESTION 8: REPLICATION

A) Describe the data-centric and client-centric consistency models.
   Indicate what are the main advantages and disadvantages of using one over the other.

B) Describe the Pipelined Random Access Memory (PRAM) consistency model.
   Indicate and justify whether the processes below follow the PRAM consistency model.

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P1 W(x)a
─────────────────────────────────
P2        W(x)c W(x)b
─────────────────────────────────
P3               R(x)b  R(x)a  R(x)c
─────────────────────────────────
```

```
P1 W(x)a
─────────────────────────────────
P2     R(x)a W(x)b W(x)c
─────────────────────────────────
P3               R(x)b R(x)a R(x)c
─────────────────────────────────
P4               R(x)a R(x)b R(x)c
─────────────────────────────────
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(a)   **(b)**