Dept. Math. & Comp. Sc. **Distributed Systems**
Vrije Universiteit **07.08.2000**

1a Explain what is meant by *middleware*. *5pt*

1b What is a multitiered client-server architecture? *5pt*

1c Give examples of how to make a client-server system scalable. *5pt*

2a Outline a general implementation for method invocation of remote objects. *5pt*

2b Explain how a systemwide object reference can be implemented as a proxy. *5pt*

2c Give a brief comparison between remote method invocations (RMIs) and remote procedure calls (RPCs). *5pt*

2d What is an important scalability problem with remote objects, and how can that be solved? *10pt*

3a What is a transaction? *5pt*

3b What is a distributed transaction? *5pt*

3c What is the difference between centralized two-phase locking, primary two-phase locking, and distributed two-phase locking? *10pt*

4a In a *k fault tolerant* server group, how many servers are needed if we assume arbitrary failures can occur? Explain your answer. *5pt*

4b Achieving complete failure transparency is virtually impossible. Give an example illustrating the difficulty of hiding failures in general. *10pt*

4c Explain how two-phase commit works. *5pt*

4d Explain what happens when a process crashes during the two-phase commit protocol. *10pt*

Grading: *The final grade is calculated by accumulating the scores per question (maximum: 90 points), and adding 10 bonus points. The maximum total is therefore 100 points.*