Question 1: Query Execution (Part II) . . . . . [190 points]

(i) **[10 points] Parallel Query Execution:**
Define total cost of ownership. Distinguish between capital and operational expenditures.

(ii) **[10 points] Parallel Query Execution:**
Distinguish between parallel and distributed DBMSs.

(iii) **[10 points] Process Models:**
List the types of process models.

(iv) **[10 points] Process Models:**
List a benefit and a drawback of a multi-threaded architecture.

(v) **[10 points] Process Models:**
Define a scheduler. Why does a DBMS know more than the OS w.r.t. scheduling?

(vi) **[10 points] Execution Parallelism:**
Distinguish between inter- and intra-query parallelism.

(vii) **[10 points] Execution Parallelism:**
Explain the producer/consumer paradigm in intra-query parallelism.

(viii) **[10 points] Execution Parallelism:**
How can you parallelize the Grace Hash Join algorithm?

(ix) **[10 points] Execution Parallelism:**
Distinguish between inter- and intra-operator parallelism.

(x) **[10 points] Execution Parallelism:**
Explain the purpose of the exchange operator in intra-operator parallelism.

(xi) **[10 points] Execution Parallelism:**
List the types of exchange operators.

(xii) **[10 points] Execution Parallelism:**
Justify why intra-operator parallelism is horizontal and inter-operator parallelism is vertical.

(xiii) **[10 points] I/O Parallelism:**
List the types of I/O parallelism.

(xiv) **[10 points] I/O Parallelism:**
List the types of database partitioning.

(xv) **[10 points] I/O Parallelism:**
Why is it useful to keep partitioning transparent to the application?

(xvi) **[10 points] I/O Parallelism:**
Distinguish between vertical and horizontal relation partitioning.

(xvii) **[10 points] I/O Parallelism:**
List the types of horizontal relation partitioning.

Question 1 continues…

(xviii) **[10 points] Parallelism:**
Which type of parallelism is more important in a disk-oriented DBMS: I/O or CPU parallelism?

(xix) **[10 points] Parallelism:**
Which type of parallelism is more important in an in-memory DBMS: I/O or CPU parallelism?