Question 1: Data Representation ....[190 points]

(i) **[10 points] Data Representation:**
Define a tuple schema. Why is it needed in a relational DBMS?

(ii) **[10 points] Numeric Data:**
Distinguish between fixed and variable precision numbers.

(iii) **[10 points] Numeric Data:**
Distinguish between `FLOAT` and `NUMERIC` data types. Which one is faster to evaluate? Why?

(iv) **[10 points] Numeric Data:**
If your application **cannot** handle rounding errors, which data type should you use for storing numeric data?

(v) **[10 points] Numeric Data:**
What is the purpose of `scale` in `NUMERIC` data type?

(vi) **[10 points] Large Values:**
How does a DBMS store values larger than a page?

(vii) **[10 points] External Value Storage:**
List two limitations of external value storage.

(viii) **[20 points] External Value Storage:**
Why are small objects (< 256 KB) best stored in the DBMS? Why are large objects (> 1 MB) best stored in the filesystem?

(ix) **[15 points] Workloads:**
Distinguish between: (1) OLTP, (2) OLAP, and (3) HTAP worloads with respect to complexity of operations (*i.e.*number of tuples affected by the operation).

(x) **[15 points] Workloads:**
Distinguish between: (1) OLTP, (2) OLAP, and (3) HTAP worloads with respect to type of operations (*i.e.*read or write).

(xi) **[15 points] Storage Models:**
Distinguish between: (1) OLTP, (2) OLAP, and (3) HTAP worloads with respect to the optimal storage model.

(xii) **[15 points] Storage Models:**
Distinguish between: (1) NSM and (2) DSM.

(xiii) **[15 points] Storage Models:**
Why does NSM not work well for OLAP workloads?

(xiv) **[15 points] Decomposition Storage Model:**
When are embedded tuple ids needed in case of DSM?

(xv) **[10 points] Schema Changes:**
Is `ADD COLUMN` faster to execute with NSM or DSM? Justify your answer.