Honor Code of the School of Engineering

"All students taking courses in the School of Engineering agree, individually and collectively, that they will not give or receive unpermitted aid in examinations or other course work that is to be used by the instructor as the basis of grading."

-From the Graduate/Undergraduate Bulletin

I have read, understood, and agree to abide by the Honor Code of the School of Engineering.

Name: ___________________________

ID: ___________________________

Signature: _______________________

Date: ___________________________

1. [20 points] Please give the whole names for the following acronyms: CRUD, DoP, DHT, IoT, MDC, OVF, SLA, VLIW, VMM, PaaS.

2. [40 points] True or false problems with wrong-answer penalties:
   a) Data centers prefer to use the high-speed communication technology like InfiniBand?
   b) Almost all cloud services are access through a web queue.
   c) Active RFIDs need equipped with batteries.
   d) Honeypot intrusion framework prefers running on Type II VM to Type I VM.
   e) If Type I VM crashes, the host OS also crashes, but if Type II VM crashes, the host OS will not crash.
   f) GPS uses 3 or 4 geostatic satellites to locate position.
   g) Multi-tenancy allows the same user or different users run multiple applications of the same OS or different OSes on the same hardware.
   h) The cost of a single big data center with \( n \) computers is cheaper than the sum of \( n \) computers in multiple data centers at different locations.

3. [20 points] This problem refers to the redundancy techniques. Assume that when a node fails, it takes 10 seconds to diagnose the fault and another 30 seconds for the workload to be switched over.
   a) What is the availability of the cluster if planned downtime is ignored?
   b) What is the availability of the cluster if the cluster is taken down one hour per week for maintenance, but one node at a time?

4. [20 points] Which of the following tasks are done by the cloud users or the cloud service providers under SaaS, PaaS, or IaaS? a) install software or tools for development purpose, b) develop software/applications, c) control availability of the servers, d) deploy software/applications, e) upgrade new version of software or tools, f) data backup/replication/recovery, g) run software on web browser.

SaaS           PaaS           IaaS
5. [20 points] If a CPU’s maximum voltage, $V$, is cut to $V/n$, its power consumption drops to $1/n^2$ of its original value and its clock speed drops to $1/n$ of its original value. Suppose that a user is typing at 1 char/sec, but the CPU time required to process each character is 100 msec. What is the optimal value of $n$ and what is the corresponding energy saving in percent compared to not cutting the voltage? Assume that an idle CPU consumes no energy at all.

6. [20 points] A distributed file system uses a master to store 64-byte metadata in main memory about each file, each file is divided into 64-MB chunks. If the master node has 8GB main memory,
   a) How many total chunks can be supported? What is the total size of the distributed system?
   b) If there are $n$ files and the average size of files is $m$-MB, and assume there is no aggregation of small files, how much of total space is wasted due to internal fragmentation?

7. [20 points] A BCube$_k$ (with $k \geq 1$, with level 0 to level $k$) is built recursively from $n$ BCube$_{k+1}$ with $n^k$ $n$-port switches, each node is represented by a $(k+1)$-number (with each number from 0 to $n-1$).
   a) What is the best shortest path length between any two nodes, and what about the worst shortest?
   b) How many nodes have the best shortest path form node 01234? How many nodes have the worst shortest path form node 01234?

8. [20 points] A cache is a net benefit in performance if the time saved during cache hits exceeds the time lost from the additional overhead. If the typical time for a regular cache lookup is $L$, for a cache hit is $H$, for a cache miss is $M$, and the cache hit ratio is $R$, then in which condition (i.e., an equation in terms of $H, R, M,$ and $L$) using cache is more efficient?

9. [20 points] Sun and Ni’s Law is a memory-bounded speedup model which states that as computing power increases the corresponding increase in problem size is constrained by the system’s memory capacity. The memory-bounded speedup $S' = (\alpha + (1 - \alpha)G(n)) / (\alpha + (1 - \alpha)G(n) / n)$ by assuming the parallel portion of workload is increased by $G(n)$ times reflecting the increase of memory in $n$-node system, i.e., $W' = (\alpha + (1 - \alpha)G(n))W$. Let $y = g(x)$ be the function that reflects the parallel workload increase factor as the memory capacity increases $n$ times. Let $W = g(M)$ and $W' = g(nM)$ where $M$ is the memory capacity of one node. Thus, $W' = g(nG(W))$. For any power function $g(x) = ax^b$ and for any rational numbers $a$ and $b$, we have $g(nx) = a(nx)^b = n^b g(x) = G(n)g(x)$, where $G(n)$ is the power function with the coefficient as 1. Suppose one would like to determine the memory-bounded speedup of matrix multiplication. The memory requirement of matrix multiplication is roughly $3N^3$, where $N$ is the dimension of the three $N \times N$ matrices. And the computation requirement is $2N^3$. Then, what is the memory-bounded speedup $S'$?