SAMPLE GRADUATE PLACEMENT TEST

Instructions: You will have 2 hours to complete this test. The test is closed book—no notes or other aids allowed. Cell phones and other electronic devices must be stored away and are not to be taken out at any time during the exam.

Each section will be scored individually; a passing grade is a minimum score of 70% in each section.

Programming Section

1) What does a type in a programming language indicate?
   (a) a set of values that a variable of that type can take.
   (b) an operand.
   (c) an operation.
   (d) a keyword.

2) A class in an object-oriented language is:
   (a) an encapsulation.
   (b) a data abstraction.
   (c) an abstract data type.
   (d) all of the above.

3) Operator overloading in C++ allows:
   (a) the creation of new operators.
   (b) the deletion of existing operators.
   (c) the redefinition of a set of existing operators.
   (d) all of the above.

4) Which is NOT true about conditions?
   (a) They are expressions.
   (b) They can be evaluated as true or false.
   (c) They often involve some kind of comparison.
   (d) They're a type of loop.

5) When you define a variable inside a function (in most cases):
   (a) That variable only has meaning while the function is running.
   (b) That variable is available outside the function.
   (c) The variable doesn't really count.
   (d) The variable can only contain strings.

6) What is the main purpose of an object initializer / constructor?
   (a) To provide a name for the instance.
   (b) To identify the methods of the class.
   (c) To define starting values for instance variables.
   (d) To clarify the inheritance hierarchy of the class.
7) What is the purpose of a makefile?

(a) To make you miserable.
(b) It explains where the compiler can be found.
(c) It outlines the dependency relationships of the files in our project.
(d) It only works in Windows; you'll need something else for Unix and Mac.

8) Consider the following pseudocode:
\[
\begin{align*}
x &:= 1; \quad i := 1; \\
\text{while } (x \leq 1000) \{x = 2^i; \quad i = i + 1;\}
\end{align*}
\]
What is the value of \( i \) at the end of the pseudocode?

(a) 4  
(b) 5  
(c) 6  
(d) 7  
(e) 8

9) An invariant for the loop below is “\( z \cdot x^k = b^n \) and \( k \geq 0 \).”
\[
\begin{align*}
x &:= b; \quad k := n; \quad z := 1; \\
\text{While } (k \neq 0) \{ \\
\text{ if odd}(k) \text{ then } z := z \cdot x; \\
x &:= x \cdot x; \\
k &:= \lfloor \frac{k}{2} \rfloor;
\}
\]
When the loop terminates, which of the following must be true?

(a) \( b = z^n \)  
(b) \( b = x^n \)  
(c) \( x = b^n \)  
(d) \( z = b^n \)

10) Consider the following grammar:
\[
\begin{align*}
S &\rightarrow ( S ) \\
S &\rightarrow x
\end{align*}
\]
Which of the following statements is (are) true?

I. The grammar is ambiguous.

II. The grammar is suitable for top-down parsing.

III. The grammar is suitable for bottom-up parsing.

(a) I only  
(b) II only  
(c) III only  
(d) II and III only
Data Structures Section

1) A 2-D array of has $m$ rows and $n$ columns. It is saved in a linear format in the memory using column-major ordering. Assuming both the array and the matrix indices start from 1, what is the index of $(i,j)$’th entry ($i$’th row and $j$’ th column) of the matrix in the array?

(a) $(j - 1)m + i$
(b) $(i - 1)m + j$
(c) $mi + j$
(d) $nj + i - 1$

2) What is the big-O estimate for the function $f(n) = (n^3 + n)(n^2 \log n + n + 2)$?

(a) $f(n) = O(n^5)$
(b) $f(n) = O(n^6)$
(c) $f(n) = O(n^5 \log n)$
(d) $f(n) = O(n^5 + n^3)$

3) Stack is a data structure that performs:

(a) First in and last out.
(b) First in and first out.
(c) Find smallest element out of a set.
(d) Find maximum element out of a set.

4) Worst-case search complexity of a binary search tree with $n$ node is:

(a) $O(n)$
(b) $O(\lg n)$
(c) $O(n \lg n)$
(d) None of the above

5) Which of the following is true for a balanced binary search tree (BST)?

(a) A balanced BST tree is easier to store in the memory.
(b) Maintenance of a balanced BST is easier than an unbalanced tree.
(c) The worst-case complexity of search in balanced BST is smaller than the same of an unbalanced BST.
(d) The worst-case complexity of insertion and deletion in balanced BST is larger than the same for an unbalanced BST.

6) A hashing table is designed to reach an element:

(a) In an approximately fixed time.
(b) In a shortest path.
(c) In a tree.
(d) In a queue.
7) A heap data structure can be best described as a:

(a) Priority queue data structure.
(b) Dictionary data structure.
(c) An array data structure which is sorted by priority value.
(d) None of the above.

8) The most popular method of sorting large files on disks is based on:

(a) insertion sort.
(b) merge sort.
(c) quick sort.
(d) heap sort

9) The data structure to store a direct graph for schedule management is:

(a) adjacency list.
(b) adjacency matrix.
(c) depth first search tree.
(d) topological sort.

10) A minimum spanning tree requires:

(a) a binary tree over a graph.
(b) left and right subtrees have the same height.
(c) a tree reaching every node in a network while the total cost of edges is minimum.
(d) the total distance from every node to all other nodes is minimum.

**Discrete Math Section**

1) Which of the following is not true for all sets A, B, and C?

(a) If A ⊆ B and B ⊆ A, then A = B
(b) If A ≠ B and B ≠ C, then A ≠ C
(c) If A ⊂ B and C ⊇ B, then A ⊂ C
(d) All of the above are true

2) We define the set of all human beings as the set of elements satisfying one or both of the following two properties: 1) the children of a human being are human beings; 2) the parents of a human being are human beings. Which of the following is true?

(a) The set defined includes all human beings.
(b) The set defined is a null set.
(c) The set defined includes all human beings except those who are grandparents and/or grandchildren.
(d) The set includes apes in addition to human beings.
3) Which of the following identities is always true for any two matrices $A_{m\times n}$ and $B_{p\times q}$, where $m$, $n$, $p$, $q$ are integers?
   (a) $A + B = B + A$
   (b) $AB = BA$
   (c) $AA^\top = A^\top A$
   (d) none of the above

4) Which of the following logical expressions is in conjunctive normal form?
   (a) $(p \land \neg q) \lor (\neg p \land q)$
   (b) $(p \lor \neg q) \land (\neg p \lor q)$
   (c) $(p \land q) \lor (p \land \neg q)$
   (d) none of the above

5) Which of the following is true concerning functions and relations?
   (a) every function is a relation
   (b) every relation is a function
   (c) the domain of a function is always a relation
   (d) none of the above

6) Which of the following is an one-to-one function?
   (a) $f(x) = \cos(x)$
   (b) $f(x) = \sin(x)$
   (c) $f(x) = x^3 + 1$
   (d) $f(x) = x^2 + 1$

7) Which of the following is not correct?
   (a) If $|A \cup B| = |A| + |B|$, then $A \cap B = \emptyset$
   (b) $(A - B) \cap (B - A) = \emptyset$
   (c) $(A - B) \cup (B - A) = A \cup B - A \cap B$
   (d) If $A \subset B$, $B \cap C \neq \emptyset$, then $A \cap C \neq \emptyset$

8) $\max(x,y) + \min(x,y)$ is equal to
   (a) $2x$
   (b) $2y$
   (c) $x + y$
   (d) $2(x + y)$

9) How many permutations of letters a, b, c and d which have a preceding b?
   (a) 4
   (b) 24
   (c) 12
   (d) 10
10) Suppose you are offered two investment opportunities: 1) you invest $1 and you will gain $1 with probability 0.5 or lose it; 2) you invest $1 and will gain $999,999 with probability 0.000001 or lose it. Which of the following statements is true?

(a) The gain in #1 has a higher expected value and a lower variance.
(b) The gain in #2 has a higher expected value and a higher variance.
(c) Both opportunities have the same expected value in gain, but #2 has a higher variance.
(d) The gain in #2 has a higher expected value and a lower variance.

Operating Systems/Architecture Section

1) After enough time, a circuit composed of combinational logic without feedback will always show the same output for a given set of inputs.

(a) True
(b) False

2) What is the correct hierarchical storage hierarchy?

(a) register, memory, cache, disk
(b) register, cache, memory, disk
(c) cache, memory, register, disk
(d) cache, register, memory, disk

3) A pipelined processor can improve the processor performance because?

(a) Each instruction is executed faster in the pipeline.
(b) Parallelism is higher.
(c) Unified instruction and data L1 cache.
(d) Multicore architectures.

4) Which register holds the address of the next instruction to be fetched?

(a) Accumulator (AC)
(b) Instruction Register (IR)
(c) Instruction Counter (IC)
(d) Program Counter (PC)

5) What is the purpose of the floating point unit (FPU)?

(a) Makes pipelining efficient
(b) Makes integer arithmetic faster
(c) Makes some arithmetic calculations faster
(d) Makes RAM access faster

6) In which of the following situations the i-node will be needed?

(a) CPU scheduling
(b) Memory allocation
(c) Page fault handling
(d) File allocation
7) When a user program calls the function malloc(), which of the following memory segment will be used to allocate new memory?
   (a) text
   (b) global/static data
   (c) heap
   (d) stack

8) Which one is the less-privileged mode?
   (a) user mode
   (b) kernel mode
   (c) system mode
   (d) control mode

9) Which of the following is correct?
   (a) Operating System must have a graphical user interface.
   (b) Operating System manages memory, I/O devices, but not processor.
   (c) Operating System manages hardware but not software.
   (d) Operating System needs some hardware support.

10) Thrashing refers to:
    (a) Unnecessary processor scheduling.
    (b) A single processor system is in deadlock.
    (c) Excess page swapping.
    (d) Too small virtual memory space.