Answers to Questions on the Sample POCA T

1. The correct answer is (b). The ACM Code is not a legally binding code. It is possible that at some point in the future, if, for example, software professionals had to be licensed in order to practice as software engineers, then a code similar to the ACM Code might become legally binding. But that is not the case currently.

2. The correct answer is (a). Specifically, lex is a tool that allows us to create a lexical analyzer given the regular expression grammar describing the tokens of the language. And yacc is a tool that creates a parser given the context free grammar of the language. But yacc also provides facilities to handle code generation by allowing us to specify the code that should be produced corresponding to the various occurrences of the non-terminals in the parse tree corresponding to a given program.

3. The correct answer is (c). Acceptance testing is the testing performed by the customer before accepting the software.

4. The correct answer is (a). This is the “contract” in design-by-contract: The client is responsible for making sure the precondition holds a the time of the operation call; the implementer assumes the precondition holds at the start of the operation body, and is responsible for making sure the postcondition holds upon return.

5. The correct answer is (a). Consider the regular expression (00)*. This corresponds to the given language. (Some students answered (c) since every regular grammar is also context-free.)

6. The correct answer is (d). The problem is that the correctness of the links in an .html page depends on the existence (and accessibility) of other pages; and that can change dynamically as the authors of those pages modify those pages. This is similar to run-time conditions in programs where, for example, whether a given expression such as \( y/x \) will evaluate correctly depends on the values of \( x \) and \( y \) at the time of the evaluation and these values may have been read in from some input stream; so there is no way to decide this before the program is executed.

7. The correct answer is (c). Data abstraction facilities enable us to write programs in which, for example, implementation details of a given class are hidden from a client class. This makes programs easier to understand, modify, etc. However, the object code that the compiler produces will not include such abstraction. In some situations, it is possible that if a programmer could violate data abstraction, that he or she could produce code that is more efficient; but in most cases, a good optimizing compiler can go from the program that faithfully abides by data abstraction principles to equally efficient code.

8. The correct answer is (c). Garbage collection is a facility that frees the programmer from having to explicitly deallocate space allocated for objects created dynamically (by using constructs such as new in C++ or Java). Instead, the runtime system keeps track of these objects and deallocates the space once there are no usable references to these objects. There is no connection to the parameter passing mechanism(s) used by a language that provides this.

9. The correct answer is (c). “Cross join” is simply the cross product of the two sets.

10. The correct answer is (a). “Group by gender” decides the cardinality. If all the students were males, the answer would be 1; similarly if all the students were female. Otherwise, the answer will be 2.
11. The correct answer is (c). Answer (a) contains a correct statement in the first part, but the difference in address lengths has nothing to do with why DMA (as opposed to some other approach) is used for disk-memory transfers. Answer (b) is generally not a correct statement in that disk tracks and memory page size need not be equal; in any case there is no relationship between the rationale for DMA and this issue.

12. The correct answer is (d), i.e. B is faster but A has the higher MIPS rating. First consider speed. The CPU time is $\text{Instr\_Count} \times \text{CPI} / \text{Clock\_Rate}$. Hence, for Computer A, we get,
   
   \[ 10 \times 10^9 \times 1 / (4 \times 10^9) = 2.5 \text{ sec} \]
   
   For B,
   
   \[ 8 \times 10^9 \times 1.1 / (4 \times 10^9) = 2.2 \text{ sec} \]
   
   so B is faster. MIPS rating is $\text{Instr\_Cont} / (\text{CPU\_time} \times 10^6) = \text{Clock\_Rate} / (\text{CPI} \times 10^6)$. Hence, for A we get,
   
   \[ 4 \times 10^9 / (1 \times 10^6) = 4000 \]
   
   and for B,
   
   \[ 4 \times 10^9 / (1.1 \times 10^6) = 3636 \]
   
   Hence A has higher MIPS rating.

13. The correct answer is (e). An address consists of two parts: page number and offset. This virtual memory consists of 256 pages. Since 256 = $2^8$ we need 8 bits to distinguish the pages. Each page contains 512 bytes. 512 = $2^9$ giving us 9 bits for the offset – allowing a unique id for each byte in the page. Thus, an address is $8 + 9 = 17$ bits.

14. The correct answer is (c). The Shortest Job First algorithm always chooses the job with the shortest CPU burst when picking a job to place on the CPU. In this problem we have 5 jobs. However, we can’t choose the job with the shortest burst to run at time 0 since that job, $P_3$, doesn’t arrive until time 3. In general, we can’t schedule a job before it arrives. Thus, at time 0 we are limited to $P_0$ and $P_1$. We schedule $P_1$ which completes at time 2. At time 2 we can choose between $P_0$ and $P_2$ and we schedule $P_2$ which ends at time 4. At that point we choose between $P_0$ and $P_3$ and run $P_3$. We then run $P_4$ and conclude with $P_0$.

15. The correct answer is (c). Solving the recurrence relation given we see that at the first level (imagining a recursion tree) we do $cn$ work. At the next level we do $cn/2$ and then $cn/4$ at the level after that. In general, at level $i$ we do $cn/2^i$ work. Since the problem size decreases by a factor of 2 from one level to the next there are $lgn$ levels in the recursion tree. Summing $cn/2^i$ over the $lgn$ levels we get a high order term of $2cn$. This leaves (c) and (d) as possible answers. Because the problem states that the recurrence is based on a worst-case analysis we conclude that the $O$-notation is correct.

16. The correct answer is (b). Choosing a data structure can be tricky. Any of the data structures listed support the operations in question. But we want to answer the questions as efficiently as possible. Note that all of the data structures except one will require linear time for at least one of the operations. For example, there is no facility for finding the maximum element in a hash table save searching the entire structure. This requires time linear in the number of elements. The same is true of an unsorted linked list (unless we maintain a pointer to the max element in which case finding the new max when removing the max requires linear time). In a sorted linked list we can very quickly report or remove the maximum element but insert takes linear time. For the array it isn’t specified whether it is in sorted order. If it is, then insert requires linear time (since we may have to “shift” a linear number of elements). If not, then we have the same scenario as for an unsorted linked list. This leaves only the heap. The heap data structure, recall, keeps the maximum element at the top and maintains the property that no node contains a value larger than that of its parent. Since the max element is at the top we can report the value in constant time. To remove the max, we “promote” an element from the bottom of the heap to the top. This may cause violations of the heap property so we now sift that element down fixing violations. Since the heap has height $lgn$ this requires $O(lgn)$ time. Finally to insert, we place the new element at the bottom of the heap and percolate it up to its correct position. This also requires $O(lgn)$ time. Since $lgn$ is exponentially smaller than $n$, the $lgn$ times for the heap are much better than the linear time operations for each of the other choices.
17. Most students who took the test seemed to feel that the length of the test was “just right”.

18. Most students felt that the difficulty of the test was also “just right”, although some felt it was too difficult.

19. Most students wanted to know how they did in the test (some said they were not sure, and a couple of the students wanted to be left alone!)

20. Most students felt that students should have the option of providing their names but should not be required to do so.