Entrance Examinations – 2016

Ph.D. Computer Science

Time : 2 Hours   Maximum Marks : 75

Hall Ticket No. [ ][ ][ ][ ][ ][ ][ ][ ]

Instructions

1. Write your Hall Ticket Number in the box above **and** on the OMR Answer Sheet .

2. This test is for **2 hours duration** carrying 75 marks.

3. All Answers should be marked clearly in the OMR answer sheet.

4. Every correct answer get **1 (ONR) mark. There is negative marking of 0.33 marks for every wrong answer.**

5. Do all the rough work only in the pages provided in the question booklet, **nowhere else.**

6. Use of non-programmable calculator and log-tables is allowed.

7. Hand over the **OMR answer sheet** to the Invigilator before leaving the examination hall.

M-53

1. Consider the binary representation of an integer x by $b_m b_{m-1} \ldots b_1 b_0$, where each b_i is either 0 or 1. The integer x is divisible by 6 *if and only if*

   A. $\sum_{i=0}^{i=m} b_i$ is divisible by 6

   B. $\sum_{i=0}^{i=m} b_i$ is divisible by 6 *and* $b_0 = 0$

   C. the alternating sum $b_0 - b_1 + b_2 - \ldots (-1)^m b_m$ is 0

   D. the alternating sum $b_0 - b_1 + b_2 - \ldots (-1)^m b_m$ is divisible by 3 *and* $b_0 = 0$

2. Which of the following protocols has all of the properties: (i) imposing restrictions on the order of items being accessed, (ii) ensuring serializability without the requirement of two phase locking, and (iii) additionally ensuring deadlock freedom.

   A. Three phase locking

   B. Time stamp ordering

   C. Graph based locking

   D. Strict two phase locking

3. The property which ensures "once a transaction completes successfully, the changes it has made to databases persist, even if there are subsequent failures" is called

   A. Atomicity

   B. Consistency

   C. Isolation

   D. Durability

4. Which of the following is an index mechanism, where an index record appears for only some of the search key values?

   A. Dense index

   B. Sparse index

   C. Multi-level index

   D. None of these

5. In the context of databases SET concept is used in

   A. Relational Model

   B. Network Model

   C. Hierarchical Model

   D. Physical Model

6. Databases that store information about the states of real world along with timeline are

   A. Temporal databases

   B. Mobile databases

   C. Multimedia databases

M-53

D. Spatial databases

7. The condition - "there are no non−trivial functional dependencies of attributes on anything other than a superset of a candidate key", is both necessary and sufficient for a database to be in

    A. 2^{nd}Normal form

    B. 3rd Normal form

    C. PJNF

    D. BCNF

8. A sequence of length 10 bits is randomly generated. The probability that at least one of these bits is zero is equal to

    A. $\frac{1023}{1024}$

    B. $\frac{1}{2}$

    C. 1

    D. $\frac{9}{1024}$

9. In a University, 1232 students have taken a course in Spanish, 879 have taken a course in French and 114 have taken a course in Russian. Further, 103 have taken course in both Spanish and French, 23 have taken in course both Spanish and Russian, and 14 have taken course in both French and Russian, If 2092 students have taken at least one of Spanish, French and Russian, how many students have taken a course in all three languages

    A. 7

    B. 14

    C. 23

    D. 103

10. The relation R is represented by the matrix 'A' given as

$$\begin{pmatrix} 0 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 0 & 1 \end{pmatrix}$$

If the inverse relation of R is defined as $R^{-1} = \{(b,a)|(a,b) \in R\}$. Then the matrix representing the inverse relation is

    A. A

    B. A^{-1}

    C. AdjA

    D. A^2

11. The number of different reflexive relations on a set with n elements is

    A. $2^{n(n-1)}$

M- 53

B. 2^{n^2}

C. n^2

D. 2^n

12. $p \rightarrow q$ is logically equivalent to

A. $\neg p \vee q$

B. $p \vee \neg q$

C. $p \vee q$

D. $\neg p \vee \neg q$

13. What is the output of the following program ?

```c
#include <stdio.h>
void  main()
{
char ch=1026;
switch(ch){
 case  1: printf("Response 1"); break;
 case  2: printf("Response 2"); break;
 case  3: printf("Response 3"); break;
 default: printf("Default Response");}
```

A. Response 1

B. Response 2

C. Response 3

D. Default Response

14. What is the output of the following program ?

```c
#include <stdio.h>
int  main()
{
if (printf("ABC")) printf("True");
     else printf("False");
 return  0;
}
```

A. Compilation error

B. ABC

C. ABCTrue

D. ABCFalse

M-53

15. Which of the following declarations are legal ?
    I. `int a=0, b=1, c=2; int array[3]={a,b,c};`
    II. `int size = 3;int array[size];`
    III. `int size = 3;int array[size]= {1,2,3};`
    IV. All of the above

    A. II and III

    B. I only

    C. IV

    D. I and II

16. In the following program which segment is the variable 'p' to be stored ?

```
#include <stdio.h>
 int  main(){
 char ch = 'a'; p = & a;
 printf ("%c",*p);
 return 0;
}
```

    A. Code/text segment

    B. Data segment

    C. Stack segment

    D. BSS segment

17. Which of the following is a bottom-up approach to design a database by examining relationships among attributes ?

    A. Functional dependency

    B. Database modelling

    C. Normalization

    D. Decomposition

18. *Empdt1(empcode,name,street,city,state,pincode)* is a schema. For any *pincode*, there is only one *city* and *state*. Also for a given *street, city and state*, there is just one *pincode*. In normalization terms, *empdt1* is a relation in

    A. 1NF only

    B. 2NF and hence in 1NF

    C. 3NF and hence also in 2NF and 1NF

    D. BCNF and hence also in 3NF and 2NF and 1NF

19. Which of the following is not associated with transaction processing

    A. Confirming an action or triggering a response

    B. Producing detail summary or exception report

M-53

C. Recording a business activity

D. Maintaining a data

20. The statement, INSERT INTO INSTRUCTOR VALUES (10211, 'Smith','Biology',66000) is of type ?

A. Query

B. DML

C. Relational

D. DDL

21. The data models defined by a ANSI-SPARC database architecture are

A. Conceptual, physical and internal

B. Conceptual, view and external

C. Logical, physical and internal

D. Logical, physical, view

22. Let K_n be the complete graph on n vertices. Then which of the following is not true ?

A. K_n has $\frac{n(n-1)}{2}$ edges

B. K_n is Eulerian for all $n \geq 5$

C. K_n is Hamiltonian for all $n \geq 5$

D. K_n is Non-planar for all $n \geq 5$

23. Let T be a tree with 2016 vertices. Let n_k denotes the number of vertices in T with degree k. Then $\sum_{k=1}^{2016}(k+1)n_k =$

A. 2015

B. 4032

C. 4030

D. 6046

24. Consider an undirected weighted complete graph G with 2016 vertices listed in a set $\{v_1, v_2, ..., v_{2016}\}$ such that the weight on edge (v_i, v_j) is $2 \mid i - j \mid$. The weight of a minimum spanning tree of G is

A. 2015

B. 4030

C. 1008

D. None of the above

25. Let A be the adjacency matrix of an undirected unweighted graph G. The $(i,j)^{th}$ entry of A^k is equal to

A. The number of simple paths of length k from vertex i to j.

M-53

B. The number of walks of length k from vertex i to j.

C. The length of shortest path from vertex i to j.

D. None of these

26. In a connected planar graph, every vertex has degree 3 and every region has degree 5 or 6. Let P be the number of regions with degree 5. Then P equals to

    A. 12

    B. 10

    C. 11

    D. 13

27. In a graph G, if the set of edges incident on each vertex of G is a cut-set, then the graph G is

    A. separable

    B. nonseparable

    C. connected

    D. Eulerian

28. The number of cut-vertices in a tree with n vertices and m leaves is

    A. $n + m$

    B. n

    C. m

    D. $n - m$

29. Which of the following can be sequences of degree of vertices in a simple connected graph with 6 vertices.

    A. $5, 4, 4, 3, 2, 1$

    B. $5, 4, 4, 3, 2, 2$

    C. $5, 4, 4, 3, 2, 0$

    D. $7, 5, 4, 4, 2, 2$

30. If p is the number of active processes, and r is the number of resource types; the time complexity of the Banker's algorithm used for deadlock avoidance is denoted as

    A. $O(p^2)$

    B. $O(r^2)$

    C. $O(p^2 r)$

    D. $O(pr^2)$

31. Dining philosopher's problem deals with

    A. Process synchronization

M-53

B. Dead-lock prevention

C. Resource allocation

D. All of the above

32. The hit ratio of cache memory is the percentage of access (reads and writes)for which data are found in the cache. Write-through, Write-back are two main policies for memory updation. write-allocation is a policy whereby a cache line is allocated and loaded on a write miss. If it is assumed that write-allocation is always used, which of the following is true.

   A. Write-back usually results in a better hit ratio than write-through

   B. Write through usually results in a better hit ratio than write-back

   C. The percentage of write operations resulting in a main memory operation will never be larger for Write-back than for Write-through

   D. Write-through can only be employed in set-associative memory

33. The linux command "chmod 761 letter" is equivalent to

   A. chmod $u = 76$, $g = 61$, $o = 11$ letter

   B. chmod $a = 761$ letter

   C. chmod 167 letter

   D. chmod $u = rwx$, $g = rw$, $o = x$ letter

34. An operating system kernel minimizes the frequency of disk access by keeping a pool of internal data buffers which helps to increase the response time, this is known as ?

   A. Buffer cache

   B. Spooling

   C. Pooling

   D. Virtual memory

35. What is the minimum number of swaps that would take place, using *Bubble sort* on a list of n numbers ?

   A. $(n - 1)$

   B. $\frac{n}{2}$

   C. 0

   D. $\log n$

36. If in a data structure D 1000 insertions were interspersed with 1000 searches efficiently, assuming data in this data structure is stored following a uniform random distribution. Then the most appropriate type of data structure for D here is

   A. A linked-list maintained in sorted order

   B. A linked-list of unsorted records

M-53

   C. A binary search tree

   D. An array-based list maintained in sorted order

37. If a process is CPU-bound, which of the following statements is TRUE for better CPU utilization ?

   A. The process should be given higher priority for I/O

   B. The process should should be given higher priority for CPU

   C. The process should be given equal priority as the other process

   D. Priority has no effect over the CPU utilization in this case

38. If the capacity of the Translation Look-aside Buffer (TLB) of a 32-bit processor is 512KB and each page table entry needs 4B, what should be the size of the page for the entire page table to fit into the TLB ?

   A. 8KB

   B. 16KB

   C. 32KB

   D. 4KB

39. An operating system uses demand paging and local replacement strategy. In such a system, when no free frames are available then the number of frames allocated to a process may be:

   A. constant

   B. nothing may be said of them

   C. increased

   D. decreased

40. Which of the following statements is NOT TRUE about compile-time binding:

   I. It's an efficient use of main memory.
   II. It requires knowledge of the processor architecture and amount of main memory in the system.
   III. It does not allow swapping of the process.

   A. (I) only

   B. (I) and (II)

   C. (I) and (III)

   D. All of the above

41. A process moves from RUNNING to READY state when

   A. an interrupt occurs

   B. a page fault occurs

M-53

    C. a process goes for I/O

    D. None of the above

42. If a 16MB file has to be stored in a file system with 8KB block size, how many index blocks are required for this file if each block location entry requires 4B ?

    A. 2

    B. 4

    C. 3

    D. 1

43. The language $L = \{a^p \mid$ where p is any non-prime, non-negative integer$\}$ defined over the alphabet $\sum = \{a\}$ is

    A. Context free

    B. Regular

    C. Nonregular and does not satisfy pumping lemma for regular languages

    D. Nonregular and but satisfies pumping lemma for regular languages

44. Which of the following statements are true:

I. Complement of a recursive language is always recursive
II. Complement of a context free language is always context free
III. Concatenation of two recursively enumerable languages is always recursively enumerable

    A. (I) only

    B. (II) only

    C. (I) and (III)

    D. (II) and (III)

45. Which of the following regular expression is equivalent to $(a^* + b)^*(c + d)$?

    A. $a^*(c + d) + b(c + d)$

    B. $a^*(c + d) + b^*(c + d)$

    C. $(a^* + b)c + (a^* + b)d$

    D. $(a + b)^*c + (a + b)^*d$

46. Consider the following context free grammar where ε is null string
$S \rightarrow aSb \mid bSa \mid SS \mid \varepsilon$
which of the following best characterises the language generated by above grammar ?

    A. All palindromes over a and b

    B. All strings with equal number of a's and b's

    C. All even-length strings of a's and b's

    D. All strings of the form $a^i b^j a^k$ such that $i + j = k$

M-53

NOTE:: The questions [47-48] are based upon the following information:
Consider a 2 Kbyte cache with an 8 byte block size, the cache is initially empty and is being addressed physically and also tagged physically; direct mapping approach is used. Array A of 256 elements with 4 bytes each, and array B of 512 elements with 4 bytes each are stored at physical address 4,096 and 8,192 respectively. The following loop is then executed:

```
for (i=0;i<256;i++)
A[i]=A[i]+B[2*i];
```

47. During the execution of the loop, how many bytes will be written to memory if the cache has a write-through policy ?

    A. 0

    B. 256

    C. 1,024

    D. 2,048

48. During the execution of the loop, how many bytes will be written to memory if the cache has a write-back policy ?

    A. 0

    B. 256

    C. 1,024

    D. 2,048

49. Two processors, M-5 and M-7 implement the same instruction set. Processor M-5 uses a 5-stage pipeline and a clock cycle of 10 nanoseconds. Processor M-7 uses a 7-stage pipeline and a clock cycle of 7.5 nanoseconds. Which of the following are true ?
    I. M-7's pipeline has better maximum throughput than M-5's pipeline
    II. The latency of a single instruction is shorter on M-7's pipeline than on M-5's pipeline.
    III. Programs executing on M-7 will always run faster than programs executing on M-5.

    A. I only

    B. II only

    C. I and III only

    D. II and III only

50. In a pipelined RISC computer where all arithmetic instructions have the same cycles per instruction which of the following actions would improve the execution time of a typical program ?
    I. Increasing the clock cycle rate
    II. Disallowing any forwarding in the pipeline

M-53

III. Doubling the sizes of the instruction cache and the data cache without changing the clock cycle time

A. I only

B. III only

C. I and II only

D. I and III only

51. A virtual memory system has an address space of 8K words, a memory space of 4K, and a page and block sizes of 1K words. The following page reference changes occur during a given time interval. (only pages with changes are listed. A page already referenced is not listed again)

4 2 0 1 2 6 1 4 0 1 0 2 3 5 7

Determine the four pages that are resident in the main memory after the end of the page reference changes if the replacement algorithm used is LRU.

A. 1,2,7,5

B. 0,2,7,5

C. 2,7,3,5

D. None of the above

52. A student is browsing the website `www.youhoo.co.in` She clicks on a URL which is from the same website. Which of the following is a more accurate description of the *sequence* of events that takes place after the click event

I. 3-way TCP handshake event between client and server
II. HTTP get request event
III. DNS query and response event

A. III, I, II

B. I, II, III

C. III, II, I

D. None of these

53. Two programs *A, B* have the following sequences of socket calls
A: `socket()`, `bind()`, `listen()`, `accept()`, `read()`, `write()`, `close()`
B: `socket()`, `sendto()`, `recvfrom()`, `close()`
Which of the following most accurately represents the work being done by program *A* and *B* respectively ?

A. connectionless client and connectionless server

B. connection-oriented client and connectionless server

C. connection-oriented server and connectionless client

M-53

D. connection-oriented client and connectionless server

NOTE: The questions [54-55] are based upon the following information:
Automatic Repeat Request Protocol (ARQ) is used for reliable data transfer between two peers. *Stop-and-Wait* is one of the well known ARQ methods between a network sender agent A and a receiver agent B. ARQ requires retransmission of the previous frame or packet to take place when the retransmission timer is set after the time limit elapses.

54. Consider the following scenario between A and B agents in a *Stop-and-Wait* ARQ protocol
   1. Sending agent A transmits a frame numbered 0 and then waits for an acknowledgment (ACK) frame from receiver B.
   2. Frame 0 is received by B without error. B transmits ACK frame to A. According to this ARQ protocol, Agent A can transmit frame numbered 1 provided, which of the following events take place ?

   A. ACK from B is received without error and retransmission timer at A is set

   B. ACK from B is received without error and retransmission timer at A is off (reset)

   C. ACK from B is received with error and retransmission timer at A is off (reset)

   D. ACK from B is not received and retransmission timer at A is set

55. The main problem with the *Stop-and-Wait* ARQ approach which needs improvement leading to *Go-back N* or *Selective Repeat* ARQ approaches is

   A. *Stop-and-Wait* is not actually reliable

   B. *Stop-and-Wait* cannot be used at transport layer level

   C. *Stop-and-Wait* requires wireless transmission

   D. *Stop-and-Wait* is not at all efficient at utilizing the transmission capacity of the link

56. IP addresses are generally written in the dotted-decimal notation. Given the IP address in binary is

   10000000100001110100010000000101

   Using dotted decimal notation it is written as

   A. 100.000001.00001.100

   B. 80.87.66.05

   C. 135.128.68.5

   D. 128.135.68.5

57. Which of the following is *not* provided by UDP:
   I. Source Port   II. Destination Port   III. Reliable transport service   IV. Count of number of bytes in datagram

M-53

A. III Only

B. IV only

C. II and IV

D. III and IV

Read the passage below and then answer the questions (58 – 61).

Many differing views have been expressed with regard to the relation of the state of the brain to the phenomenon of consciousness. There is remarkably little consensus of opinion for a phenomenon of such obvious importance. It is clear, however, that all parts of the brain are not equally involved in its manifestation. For example, as hinted above, the cerebellum seems to be much more of an 'automaton' than the cerebrum. Actions under cerebellar control seem almost to take place by themselves without one having to think about them. While one may consciously decide to walk from one place to another, one does not often become aware of the elaborate plan of detailed muscle movements that would be necessary for controlled motion. The same may be said of unconscious reflex actions, such as the removal of one's hand from a hot stove, which might be mediated not by the brain at all but by the upper part of the spinal column. From this, at least, one may be well inclined to infer that the phenomenon of consciousness is likely to have more to do with the action of the cerebrum than with the cerebellum or the spinal cord.

58. The actions that happen mostly by itself without being consciously planned, are controlled by

    A. Cerebrum control

    B. Cerebellum control

    C. Cerebellar control

    D. Spinal cord control

59. Consciousness is possibly more to do with the actions of

    A. Cerebrum

    B. Cerebellum

    C. Spinal cord

    D. All the above

60. Which of the statements below is correct I. Brain is solely responsible for individual's consciousness
II. Parts of a brain are equally involved in making of one's consciousness

    A. I

    B. II

    C. I and II

    D. None of the above

M-53

61. Unconscious reflex actions are the set actions planned by

    A. Cerebrum

    B. Cerebellum

    C. Spinal cord

    D. All the above

62. Using the standard C library which of the following will return zero for a strict equality testing of two arrays pointed by s1 and s2?
    I. `int memcmp(const void *s1, const void *s2, size_t n))`
    II. `array array_diff_assoc( array $s1, array $s2 );`
    III. `int bcmp(const void *s1, const void *s2, size_t n);`

    A. II only

    B. I and II only

    C. II and III only

    D. I and III only

63. Consider the statements
    I. `int *func(int a, float b);` and
    II. `int (*func)(int a, float b);`
    Which of the following is more correct regarding statements I and II respectively ?

    A. they represent function returning pointer to `int` and pointer to function returning `int`

    B. both are equivalent and are returning `int`

    C. both are equivalent and are returning a pointer to type `int`

    D. neither of them is returning a pointer to type `int`

64. Which of the following standard C library functions is best used to find the last occurrence of a character in a string ?

    A. `strnstr()`

    B. `strrchr()`

    C. `strstr()`

    D. None of these is useful. Its better to use `strcmp()`

65. Let T be a balanced tree with height 5. It is seen that every internal node in T at depth k from the root node, has 2^{5-k} child nodes. The number of leaf nodes in T is

    A. 2^5

    B. 2^6

    C. 2^{30}

14

D. 2^{15}

66. In which of the following parameter passing mechanisms the actual parameters are re-evaluated on each access ?

    A. Call by Name

    B. Call by Value

    C. Call by Value Result

    D. Call by Result

67. Time complexity of an algorithm is denoted by $T(n)$, where n is the input size. For a particular algorithm: $T(n) = T(n-1) + 1/n$, if $n > 1$, also note that $T(n) = 1$ otherwise. The time complexity of this algorithm is best approximated by

    A. $\log n$

    B. n

    C. n^2

    D. n^n

68. Which of the following is the most accurate description of the Breadth-First graph traversal approach ?

    A. Traverses a single path of the graph until it visits a node with no successor

    B. Finds the short past through the graph

    C. Traverses all successors of a visited node before visiting any successors of any of those successors

    D. Traverses and visits nodes in a random order but ensures visiting every node

69. In the following C language function, let $n \geq m$. How many recursive calls are made by this function ?

```
int gcd(n,m)
{
if(n%m ==0) return m;
n=n%m;
return gcd(n,m)
}
```

    A. $\Theta(\log_2 n)$

    B. $\Omega(n)$

    C. $\Theta(\log_2 \log_2 n$

    D. $\Theta(\sqrt{n})$

70. A B-Tree of order 4 is built from scratch by 10 successive insertions. What is the maximum number of node splitting operations that may take place ?

    A. 5

B. 6

C. 4

D. 3

71. What is the time required to insert n more elements to a binary heap of n elements ?

    A. $\theta(n \log n)$

    B. $\theta(\log n)$

    C. $\theta(n^2)$

    D. $\theta(n)$

72. A clustering index is defined on the fields which are of type

    A. non-key and non-ordering

    B. non-key and ordering

    C. key and ordering

    D. key and non-ordering

73. Let X be a binomial random variable with $n = 5$ and $p = 0.5$. Consider random variable Y defined as $Y = X \bmod 2$. Then $Pr(Y = 0)$ is

    A. $\dfrac{1}{32}$

    B. $\dfrac{1}{8}$

    C. $\dfrac{1}{2}$

    D. 1

74. The general expression for the sequence a_n where $a_n = 4a_{n-1} + 5a_{n-2}$, $a_1 = 2$ and $a_2 = 6$ is

    A. $\dfrac{8}{30}5^n + \dfrac{2}{3}(-1)^n$

    B. $\dfrac{8}{30}5^n - \dfrac{2}{3}(-1)^n$

    C. $\dfrac{8}{30}5^n - \dfrac{2}{3}(1)^n$

    D. $\dfrac{-8}{30}5^n - \dfrac{2}{3}(-1)^n$

75. Choose the best data structure that can be used by a search engine for ranking, accumulating score and presenting top ten results based on their scores.

    A. a binary search tree

    B. a heap

    C. a stack

    D. a queue

M.53