

G-62

Entrance Examination (2014)

## Ph.D. in Computer Science

Time: 2 Hrs.

Max. Marks: 75

Hall Ticket Number:

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### INSTRUCTIONS

1. Write your hall ticket number in the box above **and** on the OMR sheet.
2. This test is for **2 hours duration** carrying 75 marks.
3. All answers should be marked clearly in the OMR sheet.
4. Every correct answer gets **1(ONE) 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 table is allowed.
7. Handover the OMR answer sheet to the Invigilator before leaving the examination hall.
8. **The use of cellphone is strictly prohibited in the examination hall. All cellphones must be switched off when in you are in examination hall.**

1. One way of showing that one string is equal to another string is to compare and match them character by character. What happens if we allow both the strings to be of *infinite* length?
  - A. The method fails because we can *only show that the two strings are not equal*.
  - B. The method fails because we can *only show that the two strings are equal*.
  - C. The method works correctly and tells if the strings are equal or not.
  - D. The method works only if the strings are *numeric*.
2. In the C Programming Language, arrays can be defined in two ways. The first is static: `int a[4000][3000]`; the second is dynamic: declare as `int **a`; and then allocate memory using `malloc()`. Which of the following is then TRUE?
  - A. In the first case, memory is *contiguous* while in the second case, memory is *not* contiguous.
  - B. In the first case, elements may be accessed as `a[i][j]`, while in the second, they cannot be accessed so.
  - C. In the first case, the array elements are stored in *row-major* order, while in the second they are stored in *column-major* order.
  - D. None of the above.
3. If *flexibility* is defined as having maximum choice in cache placement, which of the following is correctly ordered in ascending order of flexibility?
  - A. Direct Mapping, Set-Associative Mapping, Associative Mapping
  - B. Set-Associative Mapping, Direct Mapping, Associative Mapping
  - C. Associative Mapping, Set-Associative Mapping, Direct Mapping
  - D. None of the above.
4. *Heap sort* may be considered as
  - A. Insertion sort done on a heap data structure instead of a list.
  - B. Selection sort done on a heap data structure instead of a list.
  - C. Bubble sort done on a heap data structure instead of a list.
  - D. None of the above.
5. Which of the following is NOT a feature of the Von Neumann architecture?
  - A. Storage space for programs.
  - B. Storage space for data.
  - C. Unique next instruction for execution.
  - D. Separating instructions from data.

6. The correct result of *lexicographically* sorting

109, 20, 119, 2, 207, 27, 19

in ascending order is:

- A. 19, 109, 119, 2, 20, 27, 207
  - B. 109, 119, 19, 2, 20, 27, 207
  - C. 109, 119, 19, 2, 20, 207, 27
  - D. 2, 19, 20, 27, 109, 119, 207
7. All IP addresses in the range 186.220.64.0 to 186.220.71.254 are kept in a VLAN. The correct netmask so that messages are broadcast only within this VLAN is
- A. 186.220.255.255
  - B. 186.220.248.0
  - C. 186.220.248.255
  - D. 186.220.8.0
8. Which sentence can be generated by:  $S \rightarrow aS \mid bA$ ,  $A \rightarrow d \mid cA$
- A. *aadb*
  - B. *bccddd*
  - C. *aabccd*
  - D. None of the above
9. Which sort uses features of the key to operate in *linear* time relative to the number of elements in the array?
- A. Quick Sort
  - B. Merge Sort
  - C. Radix Sort
  - D. Bubble Sort
10. Convert FAFABA in hexadecimal into octal.
- A. 76767676
  - B. 76737672
  - C. 76727672
  - D. 76575372
11. Which of the following decision procedures does *NOT* have exponential time complexity?
- A. Graph-colouring Problem

- B. Travelling Salesperson Problem  
C. Hamiltonian Circuit Problem  
D. Linear Programming Problem
12. Simplify the following boolean expression:  $2xyz' + xy'z' + x'yz'$ ?
- A.  $xy + y'z' + x'y$   
B.  $xy + xz' + x'z'$   
C.  $(y + z')x$   
D.  $(x + y)z'$
13. Which of the following problems is solvable?
- A. Determining if a universal Turing machine and some input will halt  
B. Writing a universal Turing machine  
C. Determining if a universal Turing machine can be written in fewer than  $k$  instructions for some  $k$   
D. Determining if an arbitrary Turing machine is a universal Turing machine
14. How many possible bytes have exactly three bits on (i.e., bit = true)?
- A.  $8 * 7$   
B.  $8 * 7 * 6$   
C.  $8 * 3$   
D. None of the above
15. What is the value of  $F(4)$  using the following procedure?
- ```
function F(k: integer) : integer;  
begin  
    if (k < 3) then F := k  
    else F := F(k-1) * F(k-2) + F(k-3);  
end;
```
- A. 5  
B. 6  
C. 7  
D. 8
16. Queues serve a major role in:
- A. simulation of recursion

- B. simulation of arbitrary linked lists  
 C. expression evaluation  
 D. simulation of limited resource allocation
17. What is *True* for a complete bipartite graph  $K(3,3)$ ?
- A. it is a planar graph  
 B. it requires three colours to be minimally coloured  
 C. it is non-planar  
 D. it is isomorphic to  $K(2,4)$
18. A complete binary tree of level 5 has how many nodes?
- A. 15  
 B. 63  
 C. 25  
 D. 71
19. In the following Karnaugh map with don't care states, which values of  $X$  and  $Y$  would minimize the final function's expression length?
- |   |     |     |   |
|---|-----|-----|---|
| 0 | 0   | $X$ | 0 |
| 0 | 1   | 1   | 0 |
| 1 | $Y$ | 1   | 0 |
| 0 | 0   | 0   | 0 |
- A.  $X = 0, Y = 0$   
 B.  $X = 0, Y = 1$   
 C.  $X = 1, Y = 0$   
 D.  $X = 1, Y = 1$
20. The grammar  $G = \langle \{S\}, \{0, 1\}, P, S \rangle$ , where  $P = \{S \rightarrow SS, S \rightarrow 0S1, S \rightarrow 1S0, S \rightarrow \text{empty}\}$  will generate a:
- A. Context-free language  
 B. Context-sensitive language  
 C. Regular language  
 D. Recursively enumerable language
21. In Question 20, the language generated is?
- A.  $\{0^n 1^n \text{ where } n \geq 0\}$   
 B.  $\{0^n 1^n \text{ where } n \geq 0\} \cup \{1^n 0^n \text{ where } n \geq 0\}$   
 C.  $\{0^m 1^k \text{ where } m, k \geq 0\} \cup \{1^m 0^k \text{ where } m, k \geq 0\}$   
 D.  $\{W \text{ where } W \text{ has an equal number of 0's and 1's}\}$

Answer Questions 22 – 25 using the following reading passage:

Since the Hawaiian Islands have never been connected to other land masses, the great variety of plants in Hawaii must be a result of the long-distance dispersal of seeds, a process that requires both a method of transport and an equivalence between the ecology of the source area and that of the recipient area.

There is some dispute about the method of transport involved. Some biologists argue that ocean and air currents are responsible for the transport of plant seeds to Hawaii. Yet the results of flotation experiments and the low temperatures of air currents cast doubt on these hypotheses. More probable is bird transport, either externally by accidental attachment of the seeds to feathers, or internally, by the swallowing of fruit and subsequent excretion of the seeds. While it is likely that fewer varieties of plant seeds have reached Hawaii externally than internally, more varieties are known to be adapted to external than to internal transport.

22. The author of the passage is mainly concerned with
- A. discussing different approaches biologists have taken to testing theories about the distribution of plants in Hawaii
  - B. discussing different theories about the transport of plant seeds to Hawaii
  - C. discussing the extent to which air currents are responsible for the dispersal of plant seeds to Hawaii
  - D. resolving a dispute about the adaptability of plant seeds to bird transport
23. The author mentions
- A. two methods of transport of seeds to Hawaii, namely, currents (ocean and air) and birds
  - B. that Hawaiian ecology does not match with any other ecology of the world
  - C. that the plant variety is due only to the ecology innate to Hawaii
  - D. None of the above
24. The author asserts that
- A. Hawaiian plant variety evolved independently from flora in other parts of the world
  - B. birds can not carry plant seeds long distances
  - C. bird transport happens more due to swallowing and subsequent excretion of seeds
  - D. bird transport is more likely due to accidental attachment of the seeds to feathers
25. The author mentions *the results of flotation experiments on plant seeds* most probably in order to

- A. support the claim that the distribution of plants in Hawaii is the result of the long-distance dispersal of seeds
- B. lend credibility to the thesis that air currents provide a method of transport for plant seeds to Hawaii
- C. suggest that the long-distance dispersal of seeds is a process that requires long periods of time
- D. challenge the claim that ocean currents are responsible for the transport of plant seeds to Hawaii
26. Consider a schema  $R(A, B, C, D)$  and functional dependencies  $A \rightarrow B$  and  $C \rightarrow D$ . Then the decomposition of  $R$  into  $R_1(A, B)$  and  $R_2(C, D)$  is
- A. lossless join but not dependency preserving
- B. dependency preserving but not lossless join
- C. not dependency preserving and not loss less join
- D. part dependency preserving and lossless join
27. Given relations  $R(w, x)$  and  $S(y, z)$ , the result of select distinct  $w, x$  from  $R$ ,  $S$  is guaranteed to be same as  $R$ , provided
- A.  $R$  and  $S$  have no duplicates
- B.  $S$  has no duplicates and  $R$  is non-empty
- C.  $R$  and  $S$  have the same number of tuples
- D.  $R$  has no duplicates and  $S$  is non-empty
28. Suppose  $(A, B)$  and  $(C, D)$  are two relation schemas. Let  $r_1$  and  $r_2$  be the corresponding relation instances.  $B$  is a foreign key that refers to  $C$  in  $r_2$ . If data in  $r_1$  and  $r_2$  satisfy referential integrity constraints, which of the following is ALWAYS TRUE?
- A.  $\Pi_C(r_2) - \Pi_B(r_1) = \emptyset$
- B.  $\Pi_B(r_1) = \Pi_C(r_2) = \emptyset$
- C.  $\Pi_B(r_1) - \Pi_C(r_2) \neq \emptyset$
- D.  $\Pi_B(r_1) - \Pi_C(r_2) = \emptyset$
29. Consider the following relations  $A, B, C$ . How many tuples does the result of the following relational algebra expression contain? Assume that the schema of  $A \cup B$  is the same as that of  $A$ .

$$(A \cup B) \bowtie_{A.Id > 40 \vee C.Id < 15} C$$

| Id | Name   | Age |
|----|--------|-----|
| 12 | Arun   | 60  |
| 15 | Shreya | 24  |
| 99 | Rohit  | 11  |

Table 1: Table A

| Id | Name | Age |
|----|------|-----|
| 10 | 2202 | 02  |
| 99 | 2100 | 01  |

Table 3: Table B

| Id | Name   | Age |
|----|--------|-----|
| 15 | Shreya | 24  |
| 25 | Hari   | 40  |
| 98 | Rohit  | 20  |
| 99 | Rohit  | 11  |

Table 2: Table B

- B. 4  
C. 5  
D. 9
30. Consider the above tables A, B and C. How many tuples does the result of the following SQL query contains?
- ```
SELECT A.id
FROM A
WHERE A.age > ALL (SELECT B.age
FROM B
WHERE B.name = "Arun")
```
- A. 3  
B. 0  
C. 1  
D. 4
31. Relation R is decomposed using a set of functional dependencies, F, and relation S is decomposed using another set of functional dependencies, G. One decomposition is definitely BCNF, the other is definitely 3NF, but it is not known which is which. To make a guaranteed identification, which one of the following tests should be used on the decompositions? (Assume that the closures of F and G are available).
- A. Lossless-join  
B. BCNF definition  
C. 3NF definition  
D. Dependency-preservation
32. Consider a table T in a relational database with a key field K. A B-tree of order p is used as an access structure on K, where p denotes the maximum number of tree pointers in a B-tree index node. Assume that K is 10 bytes long; disk block size is 512 bytes; each data pointer D is 8 bytes long and each block pointer PB is 5 bytes

- long. In order for each B-tree node to fit in a single disk block, the maximum value of  $p$  is
- A. 22
  - B. 23
  - C. 32
  - D. 20
33. A B<sup>+</sup>- tree index is to be built on the Name attribute of the relation STUDENT. Assume that all student names are of length 8 bytes, disk blocks are of size 512 bytes, and index pointers are of size 4 bytes. Given this scenario, what would be the best choice of the degree (i.e. the number of pointers per node) of the B<sup>+</sup>- tree?
- A. 42
  - B. 43
  - C. 44
  - D. 16
34. Consider a hash table of size seven, with starting index zero, and a hash function  $(3x + 4) \bmod 7$ . Assuming the hash table is initially empty, which of the following is the contents of the table when the sequence 1, 3, 8, 10 is inserted into the table using closed hashing? Note that - denotes an empty location in the table
- A. 1, 8, 10, -, -, -, 3
  - B. 1, -, -, -, -, -, 3
  - C. 1, 10, 8, -, -, -, 3
  - D. 8, -, -, -, -, -, 10
35. Which of the following best describes source routing concept?
- A. The source sends packets for next hop router for forwarding according to router's tables
  - B. The source relies on OSPF optimal approach for finding the route to destination from the OSPF routers
  - C. A sequence of forwarding router's addresses is generated at source and enclosed in the IP packet header.
  - D. None of the above.
36. CSMA/CA is used in IEEE 802.11 series of standards. Which of the following is most appropriate to describe its function?
- A. Set up medium access control using a token.
  - B. Set up medium access control in which hosts may transmit on the same channel simultaneously.

- C. Establish a sequence of RTS and CTS packets to sense the channel utilisation.  
D. To reduce transmission errors in a network.
37. Congestion collapse in a network refers mainly to which of these?
- A. A denial-of-service attack
  - B. The uncontrolled cycle of increased retransmissions due to dropped packets by routers
  - C. A problem caused due to hacking of webservers
  - D. The uncontrolled injection of packets into firewall
38. Network Address Translation is mainly used for
- A. Separation of host addresses from the outer network
  - B. Finding the next host for forwarding packets from a domain
  - C. To increase the speed of accessing the Internet
  - D. Accessing a mail server
39. Three-way handshake is used for
- A. Dropping a TCP connection
  - B. Reliable establishment of a connection in the Internet Transport layer
  - C. Multiplexing between three hosts on the same LAN
  - D. Exchange of packets at data link layer
40. A DNS server is most useful for
- A. Finding the address of a host given a text query
  - B. Send an HTTP error message
  - C. Send an ICMP error message
  - D. Finding the address of the next forwarding router
41. TCP is often referred to as *slf-clocking* because
- A. TCP encodes a clock signal in each packet it sends in the TCP header
  - B. TCP allows special encoding of clock signal in packet body
  - C. TCP uses acknowledgments to trigger increase in congestion window size
  - D. TCP allows for adjustment of time for retransmissions in packet networks
42. To see that a sender's data may fit into the receiver's buffer, TCP adopts a method known as
- A. Retransmission
  - B. Dropping of packets

- C. Congestion control  
D. Flow control
43. It is known that SMTP protocol uses only ASCII data. Which of the following allows for sending any kind of data?
- A. MIME  
B. TIFF  
C. MIPS  
D. JPEG
44. Software consists of
- A. Set of instructions + Operating System  
B. Programs + Documentation + Operating Procedures  
C. Programs + Hardware Manuals  
D. Set of programs
45. Project risk factor is considered in
- A. Waterfall model  
B. Prototyping model  
C. Spiral model  
D. Iterative enhancement model
46. The outcome of construction phase may be treated as
- A. Product release  
B. Beta release  
C. Alpha release  
D. All of the above
47. FAST stands for
- A. Functional Application Specification Technique  
B. Facilitated Application Specification Technique  
C. Fast Application Specification Technique  
D. None of the above.
48. Which of the following is NOT a size measure for software?
- A. LOC  
B. Function count  
C. Cyclomatic complexity

- D. Holstead's program length
49. The most desirable form of coupling is
- A. Control coupling
  - B. Data coupling
  - C. Common coupling
  - D. Content coupling
50. For a function of  $n$  variables, boundary value analysis yields
- A.  $4n + 2$  test cases
  - B.  $4n + 1$  test cases
  - C.  $n + 4$  test cases
  - D. None of the above.
51. The process of transforming a model into source code is
- A. Forward engineering
  - B. Re-engineering
  - C. Re-structuring
  - D. Reverse engineering
52. Which of the following is NOT TRUE with respect to a simple graph?
- A. Every fully connected graph is a tree
  - B. Every minimally connected graph is a tree
  - C. Every graph with  $n$  nodes and  $n - 1$  edges is a tree
  - D. Every connected graph with no cycles is a tree
53. The number of sub-strings that can be obtained from a string of length  $n$  is
- A.  $\approx n!$
  - B.  $\approx 2^n$
  - C.  $\approx n^2$
  - D.  $\approx n^n$
54. When data to be sorted is larger than the main memory capacity, which sorting algorithm would you prefer?
- A. Heap sort
  - B. Insertion sort
  - C. Quick sort
  - D. Merge sort

55. VFAT, EXT2, EXT3 are examples of
- A. File system types
  - B. Hard disk formatting commands
  - C. CPU architectures
  - D. Instruction set design formats
56. Which of the following is FALSE with respect to regular languages?
- A. Regular languages form a subset of context free languages
  - B. Some regular languages can be infinite
  - C. Every finite language is regular
  - D. Context free languages form a subset of regular languages
57. Putnam resource allocation model is based on
- A. Putnam theory of software management
  - B. Function points
  - C. Norden/Rayleigh curve
  - D. Boehm's observations on man
58. Consider the five letters with percentage of occurrence in the text as  $a = 35\%$ ,  $b = 20\%$ ,  $c = 20\%$ ,  $d = 15\%$ ,  $e = 10\%$ . If a binary tree is generated using Huffman code algorithm, with assigning 0 to every left edge and 1 to every right edge, then the code for letter e is:
- A. 10
  - B. 110
  - C. 111
  - D. 011
59. Which design paradigm is based on Principle of Optimality?
- A. Divide and conquer
  - B. Greedy technique
  - C. Backtracking
  - D. Dynamic Programming
60. Given  $S1 = AAACCGTGAGTTATTCGTTCTAGAA$  and  $S2 = CACCCCTAAG-GTACCTTTGGTTC$ , Longest Common Subsequence (LCS) is:
- A. ACCTAGTACTTG
  - B. ACCTAGTACGTTG
  - C. ACCTAGTACTGTG

D. ACCTAGTACTTTG

61. Consider the join of a relation  $R$  with relation  $S$ . If  $R$  has  $m$  tuples and  $S$  has  $n$  tuples, then the maximum size of join is:
- A.  $mn$
  - B.  $m + 1$
  - C.  $(m + n)/2$
  - D.  $2(m + n)$
62. If text  $T$  is of size  $n$  and pattern  $P$  of size  $m$  then the Knuth-Morris-Pratt Algorithm for pattern matching runs in time
- A.  $O(m^2 + n)$
  - B.  $O(n \log_2 n)$
  - C.  $O(m + n)$
  - D.  $O(m^n)$
63. The Big-Oh estimate for an algorithm that takes  $8n \log n + 4n^{\frac{3}{2}}$  steps is
- A.  $O(n \log n)$
  - B.  $O(n^{\frac{3}{2}})$
  - C.  $O(n)$
  - D. None of the above.
64. Which command is used to remove an index from the database in SQL?
- A. DROP INDEX
  - B. REMOVE INDEX
  - C. ROLL BACK INDEX
  - D. DELETE INDEX
65. A relational scheme is in ..... if it is in 1NF and if all non prime attributes are fully functionally dependent on the relation key.
- A. Second Normal Form
  - B. Boyce Codd Normal Form
  - C. Fourth Normal Form
  - D. First Normal Form
66. A binary tree has  $n$  leaf nodes. The number of nodes of degree 2 in this tree is?
- A.  $n - 1$
  - B.  $n$

- C.  $2^n$   
D.  $\log_2 n$
67. A database trigger is:
- A. A statement that is executed by user when debugging an application program
  - B. A condition the system tests for the validity of the database user
  - C. A statement that is executed automatically by the system as a side effect of modification on the database
  - D. A statement that enables to start any DBMS
68. The natural join is equal to :
- A. Combination of Union and Cartesian product
  - B. Combination of selection and Cartesian product
  - C. Combination of projection and Cartesian product
  - D. Cartesian Product
69. Consider the following multiplicative loop of some program. What is the running time of this loop in terms of big-oh notations:
- ```
m := 1;
for i:= 1 to n do begin
    m:= m * 3;
    for j:= 1 to m do
        {Something that is O(1)}
end;
```
- A.  $O(n * m^3)$
  - B.  $O(n^3)$
  - C.  $O(3^n)$
  - D.  $O(3^m)$
70. A logical schema is
- A. standard way of organizing information into accessible parts
  - B. depends on physical storage
  - C. describes how data is actually stores on the disk
  - D. the entire database
71. Which one is a virtual table that draws its data from the result of an SQL SELECT statement.
- A. Synonym

- B. View
  - C. Transaction
  - D. Sequence
72. A B-tree of order  $m$  has maximum of ..... children
- A.  $m + 1$
  - B.  $m - 1$
  - C.  $m/2$
  - D.  $m$
73. If Cache Size is 64KB, Block size is 32B and the cache is Two-Way Set Associative. For a 32-bit physical address, the division between Block Offset, Index and Tag are:
- A. 10 bits, 10 bits, 10 bits
  - B. 17 bits, 32 bits, 16 bits
  - C. 32 bits, 64 bits, 22 bits
  - D. 5 bits, 10 bits, 17 bits
74. RAID is used for
- A. Fault tolerance and Performance in multiple disks
  - B. Used for generating speed of data access
  - C. Resource sharing tool
  - D. Rotating disks for access
75. When a process is created using `fork()`, what is shared between parent process and child process?
- A. Stack
  - B. Code segments
  - C. I/O handles
  - D. Heap