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Entrance Test for Ph.D. (Computer Science) 2017

[PROGRAMME CODE : 50004]

Question Paper Series Code : A

QUESTION PAPER

Time : 3 hours

Maximum Marks : 70

INSTRUCTIONS FOR CANDIDATES

Please read carefully the following instructions before attempting the Question Paper :

(i) Write your Name, Roll Number and Name of the Test Centre in the space provided for the purpose on the top of this Question Paper and on the OMR Sheet.

(ii) This Question Paper has Two Parts : Part—A and Part—B.

(iii) Part—A (objective-type) has 30 questions of 1 mark each. All questions are compulsory.

(iv) Part—B (objective-type) has 40 questions of 1 mark each. All questions are compulsory.

(v) **A wrong answer will lead to the deduction of one-fourth of the marks assigned to that questions.**

(vi) *Symbols have their usual meanings.*

(vii) **Please darken the appropriate circle of 'Question Paper Series Code' and 'Programme Code' on the OMR Sheet in the space provided.**

(viii) All questions should be answered on the OMR Sheet.

(ix) Answers written inside the Question Paper will **NOT** be evaluated.

(x) Calculators and Log Tables may be used. **Mobile Phones are NOT allowed.**

(xi) Pages at the end of the Question Paper have been provided for Rough Work.

(xii) **Return the Question Paper and the OMR Sheet** to the Invigilator at the end of the Entrance Test.
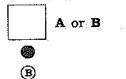
(xiii) **DO NOT FOLD THE OMR SHEET.**

/6-A

INSTRUCTIONS FOR MARKING ANSWERS ON THE 'OMR SHEET'

Use BLUE/BLACK Ballpoint Pen Only

1. **Please ensure that you have darkened the appropriate circle of 'Question Paper Series Code' and 'Programme Code' on the OMR Sheet in the space provided.**

   ### Question Paper Series Code

   Write Question Paper Series Code A or B
   in the box and darken the appropriate circle.

   ☐   **A or B**

   ●

   Ⓑ

2. Use only Blue/Black Ballpoint Pen to darken the circle. Do not use Pencil to darken the circle for Final Answer.

3. Please darken the whole circle. ●

4. Darken <u>ONLY ONE CIRCLE</u> for each question as shown below in the example :

   Example :

Wrong	Wrong	Wrong	Wrong	Correct
● ⓑ © ●	Ⓐ̷ ⓑ © ⓓ	Ⓐ̷ ⓑ © ⓓ̷	ⓞ ⓑ © ●	ⓐ ⓑ © ●

5. Once marked, no change in the answer is possible.

6. Please do not make any stray marks on the OMR Sheet.

7. Please do not do any rough work on the OMR Sheet.

8. Mark your answer only in the appropriate circle against the number corresponding to the question.

9. **A wrong answer will lead to the deduction of one-fourth of the marks assigned to that question.**

10. Write your six-digit Roll Number in small boxes provided for the purpose; and also darken the appropriate circle corresponding to respective digits of your Roll Number as shown in the example below.

    Example :

    ROLL NUMBER

1	3	5	7	2	0	2
●	①	①	①	①	①	①
②	②	②	②	●	②	●
③	●	③	③	③	③	③
④	④	④	④	④	④	④
⑤	⑤	●	⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥	⑥	⑥	⑥
⑦	⑦	⑦	●	⑦	⑦	⑦
⑧	⑧	⑧	⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨	⑨	⑨	⑨
⓪	⓪	⓪	⓪	⓪	●	⓪

PART—A

1. The solution of the recurrence relation $T(n)$

$$T(n) = 2T\left\lfloor \frac{n}{2} \right\rfloor + n$$

is

   a. $\Theta(n \log n)$

   b. $\Theta(\log n)$

   c. $\Theta(n)$

   d. $\Theta(n^2)$

2. In how many ways can 5 red and 4 white balls be drawn from a bag containing 10 red and 8 white balls?

   a. $^8C_5 \times {}^{10}C_4$

   b. $^{10}C_5 \times {}^8C_4$

   c. $^{18}C_9$

   d. $2 \times ({}^{10}C_5 \times {}^8C_4)$

3. The number of ways in which 10 candidates A_1, A_2, ..., A_{10} can be ranked in such a way that A_1 is always above A_{10} is

   a. $5!$

   b. $2(5!)$

   c. $10!$

   d. $\frac{1}{2}(10!)$

4. A survey shows that 63% of Indians like Punjabi meals, whereas 76% like South Indian meals. If $x\%$ of Indians like both Punjabi and South Indian meals, then

   a. $23 \leq x \leq 63$

   b. $23 \leq x \leq 69$

   c. $39 \leq x \leq 69$

   d. $39 \leq x \leq 63$

5. If R is a relation on $A = \{1, 2, 3, 4\}$ such that $R = \{(1, 1), (1, 2), (3, 2), (4, 2)\}$, then

    a. $R^2 = \{(1, 1), (3, 2)\}$

    b. $R^2 = \{(1, 1), (1, 2)\}$

    c. $R^2 = \{(1, 1), (4, 2)\}$

    d. $R^2 = \{(1, 1), (2, 2)\}$

6. If $P_1 = xyz'$, $P_2 = xy'z'$, where x, y and z are Boolean literals, then the value of $P_1 + P_2$ is

    a. $x'z$

    b. xz'

    c. $x'z'$

    d. xz

7. A factory production line is manufacturing bolts using three machines, A, B and C. Of the total output, machine A is responsible for 25%, machine B for 35% and machine C for the rest of the output. It is known from previous experience with the machines that 5% of the output from machine A is defective, 4% from machine B, and 2% from machine C. A bolt is chosen at random from the production line and found to be defective. What is the probability that it came from machine A?

    a. 0·231

    b. 0·362

    c. 0·348

    d. 0·294

8. If the sum and product of the mean and variance of a binomial distribution are 25/3 and 50/3, respectively, then assuming p and q to be the probabilities of success and failure respectively, the expression for $(p+q)^n$ will be

    a. $\left(\dfrac{1}{3} + \dfrac{2}{3}\right)^{15}$

    b. $\left(\dfrac{1}{4} + \dfrac{3}{4}\right)^{16}$

    c. $\left(\dfrac{1}{6} + \dfrac{5}{6}\right)^{24}$

    d. $\left(\dfrac{1}{2} + \dfrac{1}{2}\right)^{32}$

9. If A and B are two events associated with an experiment and $P(A) = 0.4$, $P(A \cup B) = 0.7$ and $P(B) = p$, then the choice of p for which A and B are mutually exclusive is

   a. 0·3

   b. 0·4

   c. 0·28

   d. 0·11

10. Consider the Hessian, H, of $f(x_1, x_2)$. If $f(x_1, x_2)$ is concave, then which of the following is true for the eigenvalues of H?

   a. $e_1 \geq e_2 \geq 0$

   b. $e_1 \leq 0$, $e_2 \leq 0$

   c. $e_1 \geq 0$, $e_2 \leq 0$

   d. $e_1 \leq 0$, $e_2 \geq 0$

11. For the optimization problem "Maximum $f(.)$ subject to $g(.) \leq 0$", a sufficient set of conditions for a local maximum to be a global maximum is

   a. $f(.)$ convex and $g(.)$ convex

   b. $f(.)$ convex and $g(.)$ concave

   c. $f(.)$ concave and $g(.)$ convex

   d. $f(.)$ concave and $g(.)$ concave

12. If you want to find the least-squares line of the form $y = ax + b$ for the given data $(2, 0)$, $(-1, 1)$ and $(1, 2)$, then which of the following error functions would you need to minimize in order to determine the values of a and b?

   a. $E(a, b) = (a + 2b)^2 + (a - b + 1)^2 + (a + b - 3)^2$

   b. $E(a, b) = (2a + b)^2 + (-a - b + 1)^2 + (a + b - 2)^2$

   c. $E(a, b) = (2a + b)^2 + (-a + b - 1)^2 + (a + b - 2)^2$

   d. $E(a, b) = (a + 2b)^2 + (-a - b + 1)^2 + (a + b - 2)^2$

13. If $\vec{a} = \hat{i} + 2\hat{j}$, $\vec{b} = -3\hat{i} + 2\hat{j}$ and $\vec{c} = 2\hat{i} + 3\hat{j} + 4\hat{k}$, then which of the following represents $(\vec{a} \times \vec{b}) \times \vec{c}$?

   a. $24\hat{i} - 16\hat{j}$

   b. $-24\hat{i} - 16\hat{j}$

   c. $-24\hat{i} + 16\hat{j} + 2\hat{k}$

   d. $-24\hat{i} + 16\hat{j}$

14. If $\vec{a} = \hat{i} + \hat{j}$, $\vec{b} = 3\hat{i} + 2\hat{j} + \hat{k}$ and $\vec{c} = \hat{i} + 2\hat{k}$, then what is the angle between $\vec{a}$ and $(\vec{b} + \vec{c})$?

   a. 33°

   b. 36°

   c. 38°

   d. None of the above

15. What is the value of p_3 if the resultant of $p = [0, 0, p_3]$, $q = [4, 0, 8]$, $u = [2, -2, 6]$ and $v = [-1, 1, 3]$ is parallel to the xy-plane?

   a. 18

   b. −15

   c. 16

   d. −17

16. If $\vec{a} = -3\hat{i} + 2\hat{j}$, $\vec{b} = 2\hat{i} + 3\hat{j} + 4\hat{k}$ and $\vec{c} = 6\hat{i} - 7\hat{j} + 2\hat{k}$, then which one of the following is the value of $(\vec{a} \times \vec{b}) \cdot \vec{c}$?

   a. 24

   b. 36

   c. 32

   d. 42

17. Which one of the following statements is false?

    a.   The rank of a matrix M equals the maximum number of linearly independent row vectors of M.

    b.   The rank of a matrix M equals the maximum number of linearly independent column vectors of M.

    c.   The matrix M and its transpose M^T have the same rank.

    d.   All of the above

18. What is the rank of the following matrix?

$$\begin{bmatrix} 3 & 0 & 2 & 2 \\ -6 & 42 & 24 & 54 \\ 21 & -21 & 0 & -15 \end{bmatrix}$$

    a.   2

    b.   3

    c.   5

    d.   6

19. What is the value of the following determinant?

$$\begin{vmatrix} 2 & 0 & -4 & 6 \\ 4 & 5 & 1 & 0 \\ 0 & 2 & 6 & -1 \\ -3 & 8 & 9 & 1 \end{vmatrix}$$

    a.   1143

    b.   1243

    c.   1234

    d.   1134

20. What is the solution to the following set of linear equations?

$$3x + 7y + 8z = -13$$
$$2x + 9z = -5$$
$$-4x + y - 26z = 2$$

    a. $x = 7,\ y = 1,\ z = 0$

    b. $x = -7,\ y = -1,\ z = 1$

    c. $x = -7,\ y = 0,\ z = 1$

    d. $x = 7,\ y = 0,\ z = -1$

21. What is the output of the following segment of C language codes?

```
main( )
{
    int a[][3] = {1, 2, 3, 4, 5, 6};
    int ( *ptr ) [3] = a;
    printf ("%d%d", (*ptr) [1], (*ptr)[2]);
    ++ptr;
    printf ("%d%d\n", (*ptr)[1], (*ptr)[2]);
}
```

a. 2 3 5 6   b. 2 3 4 5

c. 4 5 0 0   d. Garbage value

22. What is the output of the following segment of C language codes?

```
main (void)
{
    int a[ ] = { 0, 1, 2, 3, 4 };
    int *ptr = a;
    printf("%d", *ptr++);
    printf("%d", (*ptr)++);
    printf("%d", *ptr);
    printf("%d", *++ptr);
    printf("%d", ++*ptr);
}
```

a. 1 2 3 4 5   b. Compiler error

c. 0 1 2 3 4   d. 0 1 2 2 3

23. What is the output of the following segment of C language codes?

```
char p[20];
char *s = "string";
int length =. strlen(s);
int i;
for ( i = 0; i<length; i++ )
    p[i] = s [length - i];
printf("%s", p);
```

a. gnirts

b. gnirt

c. string

d. null string

24. Consider the following C function :

```
int fun (char *str1)
{
char *str2 = str1;
while(*++str1);
return (str1 - str2);
}
```

What will be the output if we call the function as fun ("SAUCSEXAM")?

a. 8

b. 9

c. 10

d. Garbage value

25. What is the output of the following segment of C language codes?

```
main()
{
    char a = '\012';
    printf("%d", a);
}
```

a. 5

b. 12

c. 10

d. Garbage value

26. If $(100)_{10} = (202)_x$, then the value of x is

a. 5

b. 7

c. 8

d. 16

27. Which one of the following is true?

    a. $(100.101)_2 = (4.625)_{10}$

    b. $(100.101)_2 = (4.5)_8$

    c. $(100.101)_2 = (4.A)_{16}$

    d. All of the above

28. The 2421 representation of the decimal number 9 is

    a. 1001

    b. 1111

    c. 1100

    d. none of the above

29. If X and Y are two unsigned binary numbers, then to obtain $(X - Y)$ using the 2's complement method, the end-carry is

    a. added

    b. discarded

    c. subtracted

    d. none of the above

30. Which one of the following is true?

    a. $X + YZ = (X + Y)(X + Z)$

    b. $\overline{X + Y} = \overline{X} \cdot \overline{Y}$

    c. $\overline{X \cdot Y} = \overline{X} + \overline{Y}$

    d. All of the above are true

PART—B

31. Which one of the following hash functions on integers will distribute keys most uniformly over 10 buckets numbered 0 to 9 for i ranging from 0 to 2020?

  a. $h(i) = i^2 \bmod 10$

  b. $h(i) = i^3 \bmod 10$

  c. $h(i) = (11 * i^2) \bmod 10$

  d. $h(i) = (12 * i) \bmod 10$

32. 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. 3

  b. 4

  c. 5

  d. 6

33. In a binary max heap containing n numbers, the smallest element can be found in _____ time

  a. $O(n)$

  b. $O(\log n)$

  c. $O(\log \log n)$

  d. $O(1)$

34. Suppose a circular queue of capacity $(n - 1)$ elements is implemented with an array of n elements. Assume that the insertion and deletion operations are carried out using REAR and FRONT as array index variables, respectively. Initially, REAR = FRONT = 0. The conditions to detect whether the queue is full or empty are

  a. Full : $(REAR + 1) \bmod n == FRONT$
     Empty : $REAR == FRONT$

  b. Full : $(REAR + 1) \bmod n == FRONT$
     Empty : $(FRONT + 1) \bmod n == REAR$

  c. Full : $REAR == FRONT$
     Empty : $(REAR + 1) \bmod n == FRONT$

  d. Full : $(FRONT + 1) \bmod n == REAR$
     Empty : $REAR == FRONT$

35. The value of the following postfix expression after its evaluation using stack is

$$7 \quad 10 \quad 5 \quad / \quad + \quad 6 \quad 2 \quad * \quad +$$

    a.   47

    b.   32

    c.   24

    d.   21

36. If preorder traversal sequence of a binary search tree is 30, 20, 10, 15, 25, 23, 39, 35, 42, then which one of the following is the postorder traversal sequence of the same tree?

    a.   10, 20, 15, 23, 25, 35, 42, 39, 30

    b.   15, 10, 25, 23, 20, 42, 35, 39, 30

    c.   15, 20, 10, 23, 25, 42, 35, 39, 30

    d.   15, 10, 23, 25, 20, 35, 42, 39, 30

37. What will the time complexity of bubble sort if data are already in sorted order?

    a. $\Theta(n \lg n)$

    b. $\Theta(n)$

    c. $\Theta(n^2)$

    d. $\Theta(1)$

38. Merge sort uses the _____ approach.

    a.   divide and conquer

    b.   backtracking

    c.   heuristic

    d.   greedy

39. Which of the following algorithm design techniques is used to find all pairs of the shortest distances in a graph?

   a.   Dynamic programming

   b.   Backtracking

   c.   Greedy

   d.   Divide and conquer

40. Suppose the letters a, b, c, d, e, f have probabilities $1/2$, $1/4$, $1/8$, $1/16$, $1/32$, $1/32$ respectively. Which of the following is the Huffman code for the letters a, b, c, d, e, f ?

   a.   0, 10, 110, 1110, 11110, 11111

   b.   11, 10, 01, 001, 0001, 000

   c.   11, 10, 011, 010, 001, 000

   d.   110, 100, 010, 000, 001, 111

41. A full binary tree with n leaves contains

   a. n nodes

   b. $2n$ nodes

   c. $\log_2 n$ nodes

   d. $2n+1$ nodes

42. The recurrence relation that arises with the complexity of the binary search is

   a. $T(n) = T(n/2) + K$

   b. $T(n) = T(n/2) + \log n$

   c. $T(n) = 2T(n/2) + K$

   d. $T(n) = T(n/2) + n$

43. Program relocation is the process of

   a.   resolving external references to symbols

   b.   modifying addresses used in address sensitive instructions of a program

   c.   relocating a program to free area in memory

   d.   loading a program from hard disk to RAM

44. Which of the following algorithms is not related to the removal, in demand page memory management?

    a. FIFO

    b. LRU

    c. Round robin

    d. None of the above

45. Which of the following statements is not true about Banker's algorithm?

    a. It can prevent deadlocks.

    b. It needs a priori information about maximum resource usage, hence is impractical.

    c. It breaks deadlock by killing some processes.

    d. None of the above

46. The partition table contains

    a. the starting and ending addresses of each partition on the disk

    b. the starting address of each partition on the disk

    c. the ending address of each partition on the disk

    d. the size of each partition on the disk

47. Which of the following is a valid deadlock prevention approach?

    a. Request all resources initially

    b. Spool everything

    c. Order resources numerically

    d. All of the above

48. Which of the following page replacement algorithms may replace important pages for bringing required page in the memory?

a. LRU

b. NRU

c. FIFO

d. All of the above

49. In the slow start phase of the TCP congestion control algorithm, the size of the congestion window

a. does not increase

b. increases linearly

c. increases quadratically

d. increases exponentially

50. An organization is granted the block 211.17.180.0/24. The administrator wants to create 32 subnets. What is the subnet mask?

a. /28

b. /29

c. /30

d. /31

51. The transport layer protocols used by DNS and email are

a. UDP, TCP

b. TCP, UDP

c. TCP, TCP

d. UDP, UDP

52. An IP router with a maximum transmission unit (MTU) of 1500 bytes has received an IP packet of size 4404 bytes with an IP header of length 20 bytes. The values of the relevant fields in the header of the third IP fragment generated by the router for this packet will be

    a. MF bit : 0, Datagram Length : 1444; Offset : 370

    b. MF bit : 1, Datagram Length : 1424; Offset : 185

    c. MF bit : 1, Datagram Length : 1500; Offset : 370

    d. MF bit : 0, Datagram Length : 1424; Offset : 2960

53. In the IPv6 header, the traffic class field is similar to which field in the IPv4 header?

    a. Fragmentation field

    b. Protocol field

    c. Type of service field

    d. Option field

54. Four channels, two with a bit rate of 300 Kbps and two with a bit rate of 250 Kbps, are to be multiplexed using multiple slot TDM with no synchronization bits. What will be the size of a frame in bits and the frame rate?

    a. 4, 75000

    b. 4, 62500

    c. 22, 50000

    d. 4, 7500

55. The additional code written for module testing is known as

    a. stub

    b. driver

    c. mutants

    d. all of the above

56. Which one of the following statements is true?

a. Mutation testing is a fault-based testing.

b. Mutation testing is a functional testing.

c. Mutation testing is nothing but fault checking.

d. All of the above

57. The module in which instructions are related through the flow of control is said to have

a. temporal cohesion

b. logical cohesion

c. procedural cohesion

d. none of the above

58. Which of the following is also known as white-box testing?

a. Unit testing

b. Integration testing

c. Structural testing

d. Beta testing

59. Execution of the following SQL statement

Select max(salary) From Employee Where salary < (Select max (salary) From Employee);
will provide the

a. highest salary

b. second highest salary

c. lowest salary

d. second lowest salary

60. $R_1(A, B, C, D, E)$ contains 7 tuples and $R_2(E, P, Q)$ contains 10 tuples. The degree of the relation obtained after applying natural join on R_1 and R_2 will be

    a. 7

    b. 8

    c. 10

    d. 17

61. Cascading rollback is avoided in

    a. tree locking protocol

    b. two-phase locking protocol

    c. strict two-phase locking protocol

    d. all of the above

62. In relational algebra, the expressions $\sigma_C(\pi_A(R))$ and $\pi_A(\sigma_C(R))$

    a. are equivalent when A uses attributes only in C

    b. produce the same result if R has a primary key

    c. are equivalent when C uses attributes only in A

    d. always produce the same result

63. In a two-phase locking protocol

    a. lock release follows lock acquisition and the two phases cannot overlap

    b. all shared locks have to be released before acquiring exclusive locks

    c. all exclusive locks have to be released before acquiring shared locks

    d. only exclusive locks are available and no record can be shared by two transactions

64. Which one of the following is true about an SQL query?

   a. It cannot perform numeric operations in predicates.

   b. A natural join operation has to be explicitly stated as an equality predicate over a Cartesian product.

   c. It cannot support nested queries.

   d. Every query has a unique representation.

65. According to IEEE standard 754 for single precision floating-point representation, the number of bits available for the exponent is

   a. 8

   b. 11

   c. 23

   d. none of the above

66. How many intermediate registers are needed for the multi-cycle implementation of an MIPS 32-bit processor?

   a. 4

   b. 5

   c. 6

   d. 7

67. What is the width of the register EX/MEM in a 32-bit MIPS pipelined data path?

   a. 97

   b. 69

   c. 102

   d. 133

68. How many addressing modes does an MIPS have?

    a.   5

    b.   6

    c.   7

    d.   8

69. Which of the following is the correct MIPS convention for memory allocation (top to bottom)?

    a.   Stack, text, dynamic data, static data, reserved space

    b.   Stack, dynamic data, static data, text, reserved space

    c.   Stack, static data, dynamic data, text, reserved space

    d.   Stack, static data, dynamic data, reserved space, text

70. Which of the following statements is true?

    a.   Set-associative caches are faster.

    b.   Multi-level caches reduce miss penalty.

    c.   Fully associative caches require searching in all the blocks for a request.

    d.   All of the above

SPACE FOR ROUGH WORK

SPACE FOR ROUGH WORK

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