# ENTRANCE TEST FOR Ph.D. PROGRAMME, 2023

## COMPUTER SCIENCE

Time : Three Hours

Maximum : 100 Marks

## Part A

*Answer **all** questions.*

*Each question carries 1 mark.*

Choose the correct answer from the choices given :

1. Which of the following is NOT a valid logical connective ?

   (a) OR.

   (b) XOR.

   (c) NAND.

   (d) INVERT.

2. Give is the negation of the statement "All birds can fly" ?

   (a) All birds cannot fly.

   (b) No birds can fly.

   (c) Some birds cannot fly.

   (d) Some birds can fly.

3. Which of the following is a tautology ?

   (a) P OR ~P.

   (b) P AND ~P.

   (c) P AND P.

   (d) P OR P.

4. What is the minimum number of edges that a connected graph with n vertices must have ?

   (a) $n - 1$.

   (b) $n$.

   (c) $n + 1$.

   (d) $n(n-1)/2$.

5. Ina bipartite graph, the maximum number of edges is achieved when :

   (a) Both parts have the same number of vertices.

   (b) One part has one more vertex than the other.

   (c) One part has two more vertices than the other.

   (d) The number of vertices in each part is irrelevant to the maximum number of edges.

**Turn over**

6. Which of the following statements is true regarding Euler's formula for planar graphs ?

    (a) It states that the number of edges minus the number of vertices plus the number of faces is always 2.

    (b) It states that the number of edges minus the number of vertices plus the number of faces is always 0.

    (c) It states that the number of vertices minus the number of edges plus the number of faces is always 2.

    (d) It states that the number of vertices plus the number of edges minus the number of faces is always 2.

7. A graph is said to be Hamiltonian if :

    (a) It contains a Hamiltonian cycle.     (b) It contains a Hamiltonian path.

    (c) It has no Hamiltonian cycles.     (d) It has no Hamiltonian paths.

8. Which of the following is a property of a planar graph ?

    (a) It can be drawn in three dimensions.

    (b) It can be drawn without any crossing edges.

    (c) It has no cycles.

    (d) It has no vertices of degree one

9. Which of the following automata models is capable of recognizing context-sensitive languages ?

    (a) Finite state automata (FSA).

    (b) Pushdown automata (PDA).

    (c) Non-deterministic finite automata (NFA).

    (d) Turing machines.

10. Which of the following automata models is not closed under complementation ?

    (a) Finite state automata (FSA).

    (b) Non-deterministic finite automata (NFA).

    (c) Deterministic finite automata (DFA).

    (d) Pushdown automata (PDA).

11. Which of the following is a property of a deterministic finite automaton (DFA) ?

    (a) It has only one final state.

    (b) It can recognize all context-free languages.

    (c) It can recognize all context-sensitive languages.

    (d) It has a stack to store its state.

12. Which of the following is true regarding the pumping lemma for regular languages ?

    (a) It can be used to prove that a given language is regular.

    (b) It can be used to prove that a given language is context-free.

    (c) It can be used toprove that a given language is context-sensitive.

    (d) It can be used to prove that a given language is not regular.

13. Which of the following is a type of microprocessor memory that is located on the same chip as the microprocessor ?

    (a) ROM.                 (b) RAM.

    (c) Cache.              (d) Secondary storage.

14. Which register is used to hold the address of the next instruction to be executed in the Intel 8086 microprocessor ?

    (a) IP.                    (b) SP.

    (c) BP.                   (d) SI.

15. Which of the following is a type of addressing mode in which the operand is specified as a direct address in the instruction itself ?

    (a) Immediate.          (b) Direct.

    (c) Indirect.            (d) Indexed.

16. Which is the technique used to improve the performance of microprocessors by executing multiple instructions simultaneously ?

    (a) Pipelining.          (b) Caching.

    (c) Superscalar processing.     (d) Branch prediction.

17. Give the correct order of memory hierarchy from smallest to largest ?

    (a) Cache, register, main memory, secondary storage.

    (b) Register, cache, main memory, secondary storage.

    (c) Secondary storage, main memory, cache, register.

    (d) Register, main memory, cache, secondary storage.

18. Which is the technique used to increase the amount of work done by a single processor by overlapping the execution of instructions ?

    (a) Parallel processing.        (b) Pipelining.

    (c) Caching.             (d) Superscalar processing.

19. In which memory organization, each memory cell has a unique address and can be accessed directly ?

    (a) Random access memory (RAM).

    (b) Read-only memory (ROM).

    (c) Programmable logic array (PLA).

    (d) Content-addressable memory (CAM).

20. Which process converts a program written in a high-level language into machine language ?

    (a) Assembly.          (b) Compilation.

    (c) Interpretation.      (d) Linking.

21. Which technique reduces the number of memory accesses by storing frequently accessed data in a small, fast memory ?

    (a) Caching.           (b) Pipelining.

    (c) Superscalar processing.    (d) Instruction level parallelism (ILP).

22. Which of the following specifies the structure of a database, including tables, fields, and relationships between tables ?

    (a) Query language.

    (b) Data definition language (DDL).

    (c) Data manipulation language (DML).

    (d) Transaction processing system (TPS).

23. Which is a database operation that combines rows from two or more tables based on a related column between them ?

    (a)  Select.                           (b)  Join.

    (c)  Group by.                       (d)  Union.

24. What is a trigger in a database ?

    (a)  A type of constraint that enforces data integrity rules.

    (b)  A stored procedure that is automatically executed when a certain event occurs.

    (c)  A way to group related data together in a database.

    (d)  A way to optimize a database for performance.

25. What is a transaction in a database ?

    (a)  A group of related SQL statements that are executed together as a single unit.

    (b)  A set of rules that govern the relationships between tables in a database.

    (c)  A process that automatically backups up a database at regular intervals

    (d)  A way to categorize and organize data in a database.

26. What is normalization in database design ?

    (a)  The process of removing redundant data from a database.

    (b)  The process of breaking down a complex database into smaller, more manageable parts.

    (c)  The process of ensuring data is consistent and accurate across multiple tables.

    (d)  The process of optimizing a database for performance.

27. In a relational database, what is a foreign key ?

    (a)  A key that uniquely identifies a row in a table.

    (b)  A key that is used to link two tables together.

    (c)  A key that is used to enforce data integrity rules.

    (d)  A key that is used to group related data together.

28. Which layer of the OSI model is responsible for routing and forwarding data across different networks ?

    (a)  Physical layer.              (b)  Data link layer.

    (c)  Network layer.               (d)  Transport layer.

29. Which protocol is used for email transmission over the Internet ?

    (a) HTTP.             (b) SMTP.

    (c) FTP.              (d) Telnet.

30. Which of the following is a characteristic of UDP ?

    (a) Connection-oriented.        (b) Reliable delivery.

    (c) Error recovery.             (d) Unreliable delivery.

31. Which of the following is a security protocol used for encrypting data transmitted over a network ?

    (a) SSL.              (b) SMTP.

    (c) HTTP.              (d) FTP.

32. Which of the following topologies allows for redundancy in case of a network failure ?

    (a) Bus.              (b) Ring.

    (c) Star.              (d) Mesh.

33. Which of the following technique ensures data confidentiality in a network ?

    (a) Encryption.             (b) Authentication.

    (c) Authorization.            (d) Intrusion Detection.

34. Which scheduling algorithm gives preference to processes with a shorter burst time ?

    (a) First-Come, First-Served (FCFS)

    (b) Shortest Job First (SJF).

    (c) Priority Scheduling.

    (d) Round Robin Scheduling.

35. Which mechanism provides protection and security in an operating system ?

    (a) Virtual Memory.         (b) Paging.

    (c) Segmentation.           (d) Access Control.

36. Which of the following is a technique used for handling multiple CPUs in an operating system ?

    (a) Multitasking.           (b) Multiprocessing.

    (c) Multithreading.          (d) All of the above.

37. Which technique tests software functionality and user interface ?

    (a) Unit testing.               (b) Integration testing.

    (c) System testing.           (d) Acceptance testing.

38. Which technique is used for modeling software design and architecture ?

    (a) Use case diagrams.        (b) Class diagrams.

    (c) Sequence diagrams.       (d) UML diagrams.

39. Which technique is used for measuring software complexity based on the number of independent paths through a program ?

    (a) Code coverage.           (b) Cyclomatic complexity.

    (c) Code review.            (d) Defect density.

40. Which of the following is a type of symmetric encryption algorithm ?

    (a) RSA.                   (b) Diffie-Hellman.

    (c) AES.                   (d) Elliptic curve.

41. Which technique is used for verifying the authenticity of a digital message ?

    (a) Encryption.             (b) Decryption.

    (c) Digital signature.        (d) Hashing.

42. Which of the following is a technique used for hiding the existence of a message within another message ?

    (a) Steganography.         (b) Cryptography.

    (c) Hashing.             (d) Digital signature.

43. Which technique used for securely exchanging keys between two parties ?

    (a) Key exchange.          (b) Digital signature.

    (c) Hashing.             (d) Encryption.

44. Which is a common notation used to express the time complexity of an algorithm ?

    (a) Big O notation.        (b) Small O notation.

    (c) Theta notation.        (d) Omega notation.

45. Which is the worst-case time complexity of linear search algorithm ?

    (a)  $O(1)$.                             (b)  $O(\log n)$.

    (c)  $O(n)$.                             (d)  $O(n\wedge 2)$.

46. Which of the following is the worst-case time complexity of binary search algorithm ?

    (a)  $O(1)$.                             (b)  $O(\log n)$.

    (c)  $O(n)$.                             (d)  $O(n\wedge 2)$.

47. Which of the following is a way to improve the time complexity of an algorithm ?

    (a)  Increase the number of input parameters.

    (b)  Increase the number of instructions executed.

    (c)  Use a more efficient algorithm.

    (d)  Use more memory.

48. Which of the following is a set of prime numbers ?

    (a)  $\{1,2,3,4,5\}$.                 (b)  $\{2,4,6,8,10\}$.

    (c)  $\{3,5,7,11,13\}$.           (d)  $\{1,3,5,7,9\}$.

49. In how many ways can 5 people be arranged in a line ?

    (a)  20.                              (b)  60.

    (c)  120.                            (d)  240.

50. What probability of rolling a sum of 7 with two fair dice ?

    (a)  1/6.                             (b)  1/36.

    (c)  1/12.                          (d)  1/18.

(50 × 1 = 50 marks)

## Part B

*Answer any* **ten** *questions.*
*Each question carries 5 marks.*

51. Describe the steps involved in writing a scientific paper. What are some common pitfalls to avoid, and how do you ensure that your paper is both clear and compelling ?

52. Briefly explain the problem discussed in a research paper that you studied. How is it solved in that paper ?

53. How are quantitative research methods different from qualitative methods ? Explain.

54. What do you mean by dependent variable and independent variable ?

55. What is Sampling ? How is it done ?

56. Which are the various measures of central tendency ? Explain their significance in research ?

57. What is linear programming ? What are its applications ?

58. What do you understand by ethics in research ?

59. What is Chi-square testing ? Where and how is it used ?

60. What do you mean by data analysis ? Mention some techniques used for data analysis.

61. Show how a computer network can be represented mathematically.

62. What do you mean by complexity of an algorithm ?

63. Describe breadth-first search and depth-first search algorithms.

64. Mention a few applications of Machine Learning.

(10 × 5 = 50 marks)