2023

COMPUTER SCIENCE

Paper-I

Time Allowed- 3 Hours *Full Marks-200*

If the questions attempted are in excess of the prescribed number, only the questions attempted first up to the prescribed number shall be valued and the remaining ones ignored.

Answer may be given in English or in Bengali but all answers must be in one and same language.

Answer any FIVE questions

1. (a) Explain the differences between Depth-First Search (DFS) and Breadth-First Search (BFS) algorithms. Provide examples of specific scenarios or problems where each would be preferable. How do their time and space complexities compare in dense and sparse graphs? 4+3+3

(b) Discuss the A* algorithm for shortest path finding. What are its strengths and limitations? Give a detailed example of a situation where the algorithm is most effective. 4+3+3

(c) Analyze and compare the Quick Sort and Merge Sort algorithms in terms of their average and worst-case time complexities. Discuss how their performance is affected by different types of input data, such as nearly sorted, reverse sorted and random data. 6+4

(d) Compare and contrast binary search trees (BST) and balanced binary search trees. Discuss scenarios where using a balanced BST is preferable over a simple BST. 6+4

2.(a) Describe in detail the process of converting a decimal number to an octal number. Provide a step-by-step example of converting the decimal number 345 to its octal equivalent. 6+4

(b) Discuss the IEEE 754 standard for floating-point representation. Explain the components of a floating-point number (sign bit, exponent and mantissa) and how they are used to represent both very large and very small numbers. 5+5

(c) Explain the von Neumann architecture and its components. Compare and contrast different following: SIMD, MIMD and vector processing. 5+5

(d) Explain the Karnaugh Map (K-map) method. Design a digital circuit that implements the following Boolean function:

$$F(A, B, C) = (A + B).(\bar{B} + C)$$ 3+7

3. (a) Explain the importance of eigenvalues and eigenvectors in numerical analysis.

$$A = \begin{bmatrix} 2 & 3 & 6 \\ 0 & 4 & 4 \\ 2 & 0 & 4 \end{bmatrix}.$$

Is 2 an eigenvalue of A, and if so, find the dimension of its eigenspace. 3+7

(b) Explain significant digits and local truncation error with examples. An approximate value of π is given by 3.1428571 and its true value is 3.1415926. Find absolute and relative errors.

3+7

(c) Solve the linear system $Ax=b$ using Gaussian elimination with pivoting :

$$A = \begin{bmatrix} 6 & 2 & 2 \\ 6 & 2 & 1 \\ 1 & 2 & -1 \end{bmatrix} \text{ and } b = \begin{bmatrix} 0 \\ 5 \\ 0 \end{bmatrix}$$

10

(d) Discuss Euler's method to compute the numerical solution of a first order and first degree differential equation. Using Euler's method, find the solution of the differential equation

$$\frac{dy}{dx} = x^2 + y^2, \quad y(0) = 0$$

In the range

$$0 \le x \le 0.5$$

taking $h=0.1$.

10

4. (a) What is a priority queue? Mention the disadvantages of linked lists. Write an algorithm to reverse a singly linked list. 1+3+6

(b) Explain operations of a stack with an example. Explain how an infix expression can be converted to a post fix expression with an example. 4+6

(c) What is a graph? Explain how graphs are represented. Explain how minimal spanning trees are constructed with an example. 1+3+6

(d) What is Binary Search Tree? Explain in brief how shortest path is calculated using Dijkstra's algorithm. 2+8

P.T.O.

5. (a) Compare AM and FM. Define modulation index and write down the expression for modulation index and total power in AM signal. 4+6

(b) Sketch the input and output characteristics of common emitter transistor configuration and explain briefly. Derive the relation between α and β for a transistor. For an npn transistor, α=0.995 and I_E=10m A. Find I_B and I_C? 5+5

(c) What are universal gates? Why they are called so? Draw and explain the functional block diagram of operational amplifier. 1+2+7

(d) What are the different types of optical fibre cables used in optical communication? Explain optical fibre communication system with block diagram. 4+6

6. (a) Discuss about 1's and 2's Complement of subtraction. Differentiate between binary code and BCD code. Convert $(5064)_9$ into base 5. 4+4+2

(b) Design XOR Gates using Universal Gates. Design Full subtractor by using Universal Gates. 5+5

(c) Explain shift registers. Design and implement 4-bit binary counter using D flipflop. 3+7

(d) Explain the differences among a truth table, state table, a characteristic table and an excitation table. A sequential circuit with 2 D Flip Flops A and B , two inputs X and Y and one output Z is specified by the following next state and output equations

$$A(t+1) = X'Y + XB$$
$$B(t+1) = X'A + XB$$
$$Z = A$$

i) Draw the logic diagram of the circuit

ii) List the state table for the sequential circuit. 4+6

7. (a) Explain Shannon channel capacity for a noisy channel. How Nyquist theorem applied for a noiseless channel? How many signal levels were needed to send 265 kbps over a noiseless channel with a bandwidth of 20 kHz? 4+3+3

(b) Compare packet switching and circuit switching. What the carrier frequency and the bit rate would be if they had an available bandwidth of 100 kHz spanning from 200 to 300 kHz and modulated their data using ASK with d = 1. 3+7

(c) What is hamming distance? In a CRC error detecting scheme, choose divisor polynomial P: $x^4 + x + 1$. Encode the bits 110101011. 3+7

(d) Explain the different types of noise that affect the performance of a communication system? Explain 2-dimensional parity check with an example. 5+5

8. Write short notes on the following topics (Any four) 10x4

(a) Pigeonhole principle

(b) CDMA process

(c) Gauss elimination method

(d) Internal and external sorting

(e) 4-bit binary counter

(f) RLC series circuit