

Time : 3 hours

Full Marks : 200

Instructions :

- (1) Answer **all** questions following directions.
- (2) The figures in the right-hand margin indicate full marks for the questions.

1. Answer any two of the following questions :

10×2=20

- (a) Why is NAND gate called a universal gate? Draw the logic diagrams to illustrate how the following logic gates can be implemented using NAND gate(s) only :

NOT, AND, OR, XOR, XNOR

- (b) Draw a state transition diagram for a binary 3-bit up counter. Derive its excitation table and obtain the circuit diagram. Use T flip-flops only.

- (c) Obtain the equivalent product-of-sums expansion for the function

$$f(w, x, y, z) = \sum m(1, 3, 4, 5, 10, 12, 13)$$

Simplify $f(w, x, y, z)$ using Karnaugh map.**2. Answer any two of the following questions :**

10×2=20

- (a) Differentiate among class variable, instance variable, automatic variable, static variable and global variable in C++ with suitable examples.

- (b) Explain how the binary search algorithm works when searching for element 33 in the following sequence :

0, 12, 28, 42, 55, 87, 91

What is the complexity for a failed search in binary search algorithm?

- (c) Explain why a skewed binary search tree is not efficient. How does AVL tree eliminate this inefficiency? Construct an AVL tree by insertion of the following integers :

11, 21, 16, 26, 31, 17, 19, 20

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3. Answer any *two* of the following questions :

10×2=20

(a) Write down the most natural 8086 addressing modes for the following high-level C statements :

(i) `x[i] = y[j];`

(ii) `int i = *ptr;`

(iii) `while (*ptr++);`

(iv) `x = y + 20;`

(v) `--i;`

(b) Using suitable diagrams, explain the architecture of 8085 processor. Explain the significance of the flag register and use of interrupts.

(c) If CS = 1000H, DS = 25A0H, BX = 43A3H, BP = 3400H, find the physical address of the source data for the following instructions :

(i) `MOVE AL, [BX + 1200H]`

(ii) `ADD BL, [BP + 05]`

Identify the addressing modes used and its significance.

4. Answer any *two* of the following questions :

10×2=20

(a) Explain the mechanism of dynamic linking with a suitable example. Differentiate between static and dynamic linking.

(b) Explain the various sections of an executable—text, bss and data. Where are the local variables stored in an executable?

(c) Differentiate between absolute loader and relocatable loader, and explain their usage.

5. Answer any *two* of the following questions :

10×2=20

(a) Explain a typical 4-stage instruction pipeline of a RISC processor containing the following stages :

Instruction Fetch, Instruction Decode, Instruction Execute, Writeback

Justify why a 4-stage pipelined processor can experience a speedup of up to 4 times.

(b) The data cache of a computer is implemented as a 4-way set associate cache with a capacity of 256 KB with a block size of 32 bytes. Memory address length is 32 bits.

(i) Compute the size of TAG, SET and OFFSET fields of an address.

(ii) Explain the purpose of VALID bit, MODIFIED bit and REPLACEMENT bit in a cache.

(c) Explain the following terms related to modern computers :

(i) TLB

(ii) Virtual Memory

(iii) Split Cache

(iv) DMA

(v) CISC Machines

6. Answer any *two* of the following questions :

10×2=20

(a) Consider the arrival times and execution times for the following processes in an operating system :

Process	Execution Time (ms)	Arrival Time (ms)
A	25	0
B	30	20
C	15	35
D	20	50

For the CPU scheduling algorithms Round Robin (time quantum of 5 ms), First Come First Served, Shortest Job First, and Shortest Remaining Time First, compute the following :

(i) The order of completion of processes

(ii) The average waiting time for a process

(b) Explain the limitations of FAT file system. Explain how an inode-base file system solves the limitations of FAT file system.

- (c) Explain why adding more RAM to computer typically improves performance. Consider a computer system with a main memory with 3-page frames. Compute the number of page faults that occurs for the page replacement algorithms—

(i) LRU;

(ii) LIFO;

(iii) FIFO;

for the page references—6, 0, 1, 2, 0, 3, 0, 5, 2, 3, 0, 3, 2, 1, 2, 0, 1, 6, 0, 1.

7. Answer any *two* of the following questions :

10×2=20

- (a) Consider the language that consists of binary strings ending with 10 or 11 :

(i) Give its regular expression.

(ii) Construct the NFA from regular expression obtained in Q7 (a) (i).

(iii) Construct a DFA from the NFA obtained in Q7 (a) (ii).

- (b) Explain why the following expression grammar causes ambiguity :

$$E \rightarrow E + E | E * E | (E) | id$$

Rewrite the grammar to remove ambiguity.

- (c) Differentiate between top-down and bottom-up parsing with suitable examples. What is syntax-directed translation?

8. Answer any *two* of the following questions :

10×2=20

- (a) Explain, using appropriate pseudo code, the pre-order, post-order and in-order traversals. Given the in-order sequence 4, 2, 5, 1, 6, 7, 3, 8 and pre-order sequence 1, 2, 4, 5, 3, 7, 6, 8. Construct the corresponding binary tree.

- (b) Explain the use of a virtual destructor in C++ with a suitable example. Why are pure virtual functions required in C++?

- (c) Explain how 1-dimensional and 2-dimensional arrays can be passed as parameter to a C function with a suitable example. Explain how to use dynamic arrays in C++ using a suitable example.

9. Answer any *two* of the following questions :

10×2=20

(a) With an example, justify the statement "Multi-valued dependencies are consequence of First Normal Form". Also explain how multi-valued dependencies are eliminated.

(b) Consider the relation :

$R(A, B, C, D, E, F)$

Suppose the following dependencies exist :

$A \rightarrow C, F$

$C \rightarrow D$

$B \rightarrow E$

Find the key of the relation. What normal form the relation is? Explain your answer. Apply normalization until you cannot decompose the relation further. State the reason behind each decomposition.

(c) Consider the relations

WORKS (Pname, Cname, Salary)

LIVES (Pname, Street, City)

LOCATED-IN (Cname, City)

MANAGER (Pname, Mgrname)

where, Pname : Person name; Cname : Company name; Mgrname : Manager name.

Write the SQL queries for the following :

- (i) List the names of the people who works for the company "Arunachal Transport" along with cities they live in.
- (ii) Find the names of the persons who live and work in the same city.
- (iii) Find the names of the persons who do not work for "Green Valley Roadways".
- (iv) Find the persons whose salary is more than that of all the "DP Hardware Ltd".
- (v) Find the name of the companies that are located in every city where the company "Green Valley Roadways" is located.

10. Answer any *two* of the following questions :

10×2=20

- (a) Write pseudo code for DDA algorithm. Using a suitable example, explain the working of this algorithm.
- (b) Write the Binary Space Partitioning (BSP) algorithm for removal of hidden surfaces.
- (c) Determine a formula for computing intensity of light at a point (x, y) on a surface using Phong shading.

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