



INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, NAGPUR

Department of Basic Sciences

MAL 201: Numerical Methods and Probability Theory

End-Sem Exam
Duration: 3 hoursBranch: CSE and ECE
Semester-IIIDate: Dec 04, 2023 (Monday)
Max. Marks: 60Important Instructions:

- (i) This is a closed book, closed notes examination.
- (ii) All questions are compulsory.
- (iii) Use of non-programming calculators are permitted.

Q1 (a) Let the random variable X have the p.d.f.

$$f(x) = \begin{cases} \frac{1}{6}, & -3 < x < 3, \\ 0, & \text{otherwise.} \end{cases}$$

If $Y = 2X^2 - 3$, then find the range and the p.d.f. of Y . [CO-4], 4 marks(b) Suppose a continuous random variable X has the pdf

$$f(x) = \begin{cases} kx^2 e^{-\frac{x}{2}}, & \text{if } x > 0, \\ 0, & \text{otherwise.} \end{cases}$$

where k is a suitable constant.

- (i) Determine the cdf of X .
- (ii) Compute the probability that X is at most 10 given that X is at least 5.

[CO-4], 5 marks

Q2 (a) Show that $V(X + Y) = V(X) + V(Y) + 2\text{Cov}(X, Y)$. [CO-4], 4 marks(b) Suppose that the random variables X and Y have the joint p.d.f.

$$f(x, y) = \begin{cases} 6(1 - x - y), & \text{if } x, y > 0, x + y < 1, \\ 0, & \text{otherwise.} \end{cases}$$

- (i) Find the marginal p.d.f. of X and Y .
- (ii) Are X and Y independent?
- (iii) Find $P(X \leq 2Y)$. [CO-4], 5 marks

Q3 (a) Let F be a cumulative distribution function (c.d.f.) of a random variable X .

- (i) If $y > 0$ and $g(x) = x^2$, Find the $P(g(X) \leq y)$ in terms of c.d.f. F .
- (ii) Find $P(a < F(X) < b)$ in terms of a and b .

[CO-4], 4 marks

- (b) Let the p.d.f. $f(x)$ be positive at $x = 1, 2, 3$ and zero elsewhere. If $E(X) = \frac{40}{21}$ and $E(X^2) = \frac{88}{21}$, then find $f(x)$. [CO-4], 5 marks

- Q4 (a) The marks obtained by a number of students in a certain subject are approximately normally distribution with mean 65 and standard deviation 5. If three students are selected at random from this group, what is the probability that atleast 1 of them would have scored above 5? [CO-5], 4 marks
- (b) It is known that the probability of an item produced by a certain machine will be defective is 0.05. If the produced items are sent to the market in packets of 20, find the number of packets containing atleast exactly and atmost 2 defective items in a consignment of 1000 packets using

(i) Binomial distribution

(ii) Poisson approximation to Binomial distribution.

[CO-5], 5 marks

- Q5 (a) Find the smallest positive root of $x^4 - x - 10 = 0$ correct to three decimal places using regula-falsi method. [CO-2], 4 marks

- (b) Find all the eigen values and corresponding eigen vectors of the matrix

Q4 Exam

$$A = \begin{bmatrix} 1 & -2 & 4 \\ -2 & 5 & -2 \\ 4 & -2 & 1 \end{bmatrix}$$

using the Jacobi's method.

[CO-1], 5 marks

- Q6 (a) Show that the sequence

$$x_{n+1} = \frac{1}{8}x_n \left(6 + \frac{3a}{x_n^2} - \frac{x_n^2}{a} \right)$$

has convergence of order three with the limit \sqrt{a} .

[CO-2], 4 marks

- (b) Given $\frac{dy}{dx} = x^2(1+y)$, $y(1) = 1$, $y(1.1) = 1.233$, $y(1.2) = 1.548$, $y(1.3) = 1.979$. Evaluate $y(1.4)$ and $y(1.5)$ using Adams-predictor-corrector method.

[CO-3], 5 marks

- Q7 Solve the system of equation $AX = B$ using LU-decomposition, where

$$A = \begin{bmatrix} 2 & 1 & 1 & -2 \\ 4 & 0 & 2 & 1 \\ 3 & 2 & 2 & 0 \\ 1 & 3 & 2 & -1 \end{bmatrix}, X = \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}, B = \begin{bmatrix} -10 \\ 8 \\ 7 \\ -5 \end{bmatrix}.$$

Take all diagonal elements of lower triangular matrix L as 1. [CO-1], 6 marks

**Important Instructions:**

- All questions are compulsory.

Q1 a) Consider a sparse matrix in Fig (a) below. Consider a way of representing sparse matrix such that we store only the non-zero elements in one-dimensional array as shown in Fig (c). [0.5+3+1.
5]
[CO1]

The elements are stored in order of row-major. In addition, we also maintain two dimensional array bits[row][column] such that-

bits[i][j]=0 if $a[i][j]=0$ and

bits[i][j]=1 if $a[i][j] \neq 0$ as shown in Fig (b) below:

| | col 0 | col 1 | col 2 | col 3 | col 4 | col 5 | |
|-------|-------|-------|-------|-------|-------|-------|--|
| row 0 | 15 | 0 | 0 | 22 | 0 | -15 | |
| row 1 | 0 | 11 | 3 | 0 | 0 | 0 | |
| row 2 | 0 | 0 | 0 | -6 | 0 | 0 | |
| row 3 | 0 | 0 | 0 | 0 | 0 | 0 | |
| row 4 | 91 | 0 | 0 | 0 | 0 | 0 | |
| row 5 | 0 | 0 | 28 | 0 | 0 | 0 | |

Fig (a)

Fig (b)

Fig (c)

(i) On a computer with w bits per word, how much storage is needed to represent a sparse matrix A with t non-zero terms?

(ii) Write a C function to add two sparse matrices A and B represented as in Fig above, to obtain $D = A + B$. How much time does your algorithm take?

(iii) What is the time requirement for random access? Suggest any improvement in the representation scheme to improve the random access time.

b) You are given a list of IP addresses in dotted-decimal notation (e.g., 192.168.1.1). Determine how you can use Radix Sort to efficiently sort these IP addresses in ascending order. Justify your answer with suitable example. [5M]
[CO1]

Q2 a) How does an AVL tree handle duplicate values? Insert values 5, 3, 7, 2, 4, 6, 8, 4, 12, 10, 7, 9 into an AVL tree, and illustrate the resulting structure. Also determine the total number of rotations required. [5M]
[CO2]

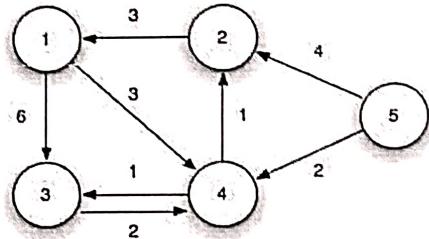
b) Web browsers maintain a history of visited pages. How could a splay tree be used to manage this history for quick access to frequently visited pages? Discuss with suitable example by inserting minimum 10 keys in a splay tree. [5M]
[CO2]

Q3 a) Consider a task scheduling system where each task has a priority associated with it. Explain how heapify can be utilized to maintain a priority queue for efficient task scheduling. Provide details on how the heapify operation is applied when adding or removing tasks from the priority queue. [5M]
[CO2]

b) Construct the standard trie for the following set of strings S : {sick, sea, sells, ship, shells, shore, shout, seem}. Identify the redundant nodes and redundant chain of edges, and convert the standard trie into compressed trie. Also, construct a suffix tree for the string $S = \text{MISSISSIPPI}$. [5M]
[CO3]

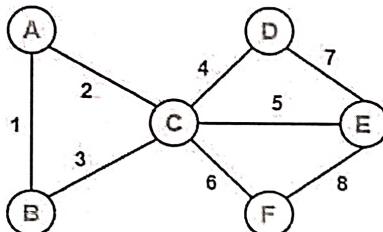
- Q4 a) A company maintains sales data in INR for a particular product month-wise. How could a segment tree be used to efficiently answer queries related to the product sale within a given time range? Discuss the key design considerations involved in implementing such a solution. Write a pseudocode for the above design. [5M] [CO3]

- b) Consider the weighted directed graph as shown in the figure below. [5M] [CO4]

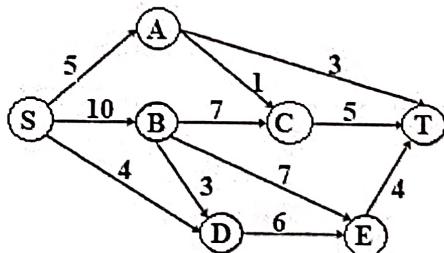


Compute the shortest distances between every pair of vertices using Floyd-Warshall all pair shortest path algorithm. Also, state and derive the time and space complexity for the algorithm.

- Q5 a) Define minimum spanning tree. Compare the differences between Kruskal's and Prim's minimum spanning tree algorithms. Find the minimum spanning tree for the following graph G using both Kruskal's and Prim's algorithm. [5M] [CO4]



- b) Consider a water distribution network given below, where water is supplied from a source reservoir to various towns through a network of pipes. The network is represented as a directed graph, with nodes representing junctions or towns and edges representing pipes. Each edge has a capacity (in thousands gallons/day) indicating the maximum water flow it can accommodate. [5M] [CO4]



Apply Ford Fulkerson algorithm to determine the maximum water flow from the source reservoir (S) to the endpoint (T). Provide a detailed step-by-step analysis, including the identification of augmenting paths, residual capacities, and the resulting maximum water flow.

**Important Instructions:**

- All questions are compulsory.

Q1 a) Consider two polynomials (i.e. poly1 and poly2) where the exponents for each i^{th} term of poly1 & poly2 are equal. Assume both polynomials are stored using a linked list in decreasing order of the exponent. Write down a function to combine the polynomials based on the following conditions: [5M]
[CO1]

If the sum of the coefficients of any term of poly1 with any term of poly2 is prime then perform the polynomial addition operation. Else if the coefficients of any one of the i^{th} term of poly1 and poly2 are coprime then perform the polynomial multiplication operation. Else append poly2 after poly1, and then sort the resultant polynomial in decreasing order of the coefficient.

b) You are analyzing a large social network graph where users interact with each other. The graph's adjacency matrix is sparse since most users have only a few connections. How linked lists can be employed to represent the sparse adjacency matrix efficiently? [5M]
[CO1]

Discuss the advantages of this representation for social network analysis.

Q2 a) Suppose you are implementing a B-tree with a maximum degree of t. Write a function `split_node(node)` that takes a node as input and splits it into two nodes, following the rules of B-trees. Your function should split the node into two nodes, `left_node` and `right_node`. [5M]
[CO2]

The original node's median key should be moved up to its parent.

If the original node is a leaf node, both `left_node` and `right_node` should also be leaf nodes.

If the original node is an internal node, `left_node` should contain the $t-1$ smallest keys and their corresponding children, and `right_node` should contain the $t-1$ largest keys and their corresponding children.

Suppose we want to insert the keys 10, 20, 5, 6, 12, 18, 34, 40, 26 and 30 into an initially empty B-tree with the degree 3. How will the B tree be evolved?

b) i) Compare Red-Black trees with other self-balancing binary search trees, such as AVL trees. [5M]
ii) In what scenarios would you choose a Red-Black tree over other data structures? Explain with suitable example. [CO2]

Q3 a) Elaborate the structure of a node in a skip list. Justify why randomization is an essential aspect of skip list design? Explain how the height of each node in a skip list is determined and its impact on the overall structure. Analyze the space complexity of skip lists. How does it compare to other data structures in terms of memory usage? [5M]
[CO3]

b) Construct the standard trie for the following set of strings [5M]
S: {mind, mist, most, miss, mount, move, milk, mop, map, mode} [CO3]

Identify the redundant nodes and redundant chain of edges, and convert the standard trie into compressed trie.

Also, construct a suffix tree for the string S = GOGOOGLE

Q4 a) How does a segment tree facilitate range queries efficiently? Explain with suitable example. What is the significance of the segment tree in handling minimum or maximum range queries? Provide examples of real-world problems that can be efficiently solved using segment trees. [5M] [CO3]

b) Explain the logic and write a pseudocode to solve the following problem using Heap Data structure: [5M]

Given M sorted lists of variable length, efficiently compute the smallest range, including at least one element from each list. One sample is shown below:

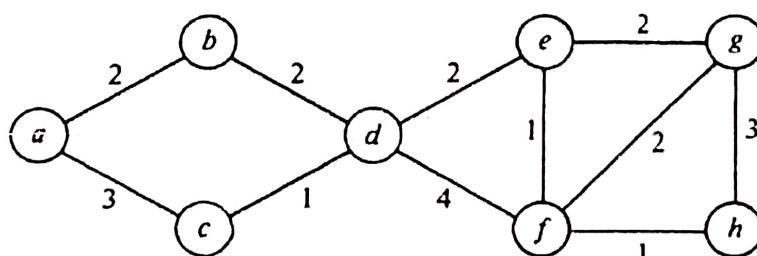
/
Input: 4 sorted lists of variable length L1:[3, 6, 8, 10, 15], L2: [1, 5, 12], L3: [4, 8, 15, 16]
L4: [2, 6]. Output: The minimum range is 4–6 as this range contains at least one element in each list.

Q5 a) Given a complete graph with 12 vertices, the following adjacency matrix gives the distance between each vertex. ∞ indicates no edge between the vertices and integer value gives the edge weight. Find the minimum spanning tree for the following matrix using Kruskal's algorithm. Draw the resulting spanning tree and list the edges in the order they are picked by Kruskal's algorithm. [5M] [CO4]

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| A | ∞ | 4 | ∞ | 4 | ∞ | ∞ | 4 | ∞ | ∞ | ∞ | ∞ | ∞ |
| B | 4 | ∞ | 1 | 2 | 4 | ∞ | ∞ | 6 | ∞ | ∞ | ∞ | ∞ |
| C | ∞ | 1 | ∞ | ∞ | 2 | 4 | ∞ | ∞ | 5 | ∞ | ∞ | ∞ |
| D | 4 | 2 | ∞ | ∞ | 3 | ∞ | 2 | ∞ | ∞ | 6 | ∞ | ∞ |
| E | ∞ | 4 | 2 | 3 | ∞ | 1 | 2 | ∞ | ∞ | ∞ | 6 | ∞ |
| F | ∞ | ∞ | 4 | ∞ | 1 | ∞ | ∞ | ∞ | 3 | ∞ | ∞ | 3 |
| G | 4 | ∞ | ∞ | 2 | ∞ | ∞ | ∞ | 5 | ∞ | 4 | ∞ | ∞ |
| H | ∞ | 6 | ∞ | ∞ | 2 | ∞ | 5 | ∞ | 5 | 4 | 4 | ∞ |
| I | ∞ | ∞ | 5 | ∞ | ∞ | 3 | ∞ | 5 | ∞ | ∞ | 2 | 4 |
| J | ∞ | ∞ | ∞ | 6 | ∞ | ∞ | 4 | 4 | ∞ | ∞ | 3 | ∞ |
| K | ∞ | ∞ | ∞ | ∞ | 6 | ∞ | ∞ | 4 | 2 | 3 | ∞ | 1 |
| L | ∞ | ∞ | ∞ | ∞ | ∞ | 3 | ∞ | ∞ | 4 | ∞ | 1 | ∞ |

b) Find a depth-first spanning tree starting at: [5M]
 i) node a
 ii) node d. [CO4]

Present a step-by-step depiction employing the essential data structures utilized in the exploration of the spanning tree.





INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, NAGPUR

Department of Computer Science and Engineering

CSL 203: Computer System Organization

END SEMESTER EXAM

Semester -III

Duration: 3 Hours

Date: 25/11/2023 (Saturday)

Time: 9:00 AM to 12:00 NOON

Max. Marks: 50M

Important Instructions:

- All the questions are compulsory. Write all the subparts of each question together.
- Maximum marks that can be obtained for a particular question are indicated in the brackets [] on the extreme right of the corresponding question

Q1. Answer the following in short by giving proper justification:

- i. Give one example of spatial locality and one example of temporal locality for the following code:
for (i=0;i<=100;i++)
 for(j=0;j<50;j++)
 x[i] = x[i]*j;
- ii. What is thrashing in Cache Memory?
- iii. Instruction Set Architecture of MIPS processor follows the principle of "Smaller is faster". Explain the principle with example.
- iv. Explain how DMA performs better than interrupt driven and program-controlled IO.
- v. Which cache replacement policy exploits the temporal locality and why?
- vi. How ISR is different from normal subroutine? Explain.
- vii. The question: "Is there floating-point division operation available in processor hardware or is it done by repeated subtraction?" talks about computer organization aspect. Justify the argument.
- viii. Why is it necessary to save and restore the value of Frame Pointer in processor stack?
- ix. Why there is a need to match the tag bits while locating a cache block in cache memory?
- x. Why subroutine linkage method which uses link register is not suitable for nested subroutine calls? Justify.

[10M, (CO-1, CO-2, CO-3, CO-4)]

Q2-a. Suppose cost of Cache Memory = Rs. 125.5 per bit and cost of Main Memory = Rs. 5.5 per bit,

- i. What is the cost of 10 MB of main memory without using cache memory technology?
- ii. What is the total cost of 10 MB of main memory which uses direct mapped cache memory with 1024 blocks and size of each block as one word?

Q2-b. A computer has 64 GByte byte addressable memory. Each block of memory stores 8 words. The computer has a direct-mapped cache of 128 blocks. What is the address format and the total size of cache including (valid+tag+data) in bytes? If we change the cache to a fully associative cache, what is the new address format and the total size of cache including (valid+tag+data) in bytes? Also, draw the fully associative cache memory for the given specifications.

[2+8 = 10M, CO-3]

Q3-a. Explain Booth's Multiplication Algorithm. Using Booth's algorithm multiply (- 21) and (+ 5). Show all the intermediate steps.

Q3-b. Find the IEEE standard 754 representation in single precision format for $(125.125)_{10}$. Show all the steps.

Q3-c. Compute and write the delay incurred in sum and carry bits of a 4-bit Ripple Carry Adder. Assume the delay in sum as 3δ and delay in carry as 2δ for a full adder.

[5+3+2 = 10M, CO-4]

PTO

Q4-a. Consider a benchmark program containing three classes of instructions: Data Transfer Instructions (DTI), Arithmetic Instructions (AI) and Square Root Instructions (SRI). The program contains 35% of DTI, 40% of AI and 25% of SRI. Total instructions in the program are 135. The number of cycles needed by one DTI is 5 cycles, one AI is 3 cycles and one SRI is 45 cycles. What is the CPI of this benchmark program if executed on MIPS processor implemented using SCD. Also, compute the total time required by the program if cycle time is 1.25 nsec.

Q4-b. If the benchmark program mentioned in Q4-a, is executed on a machine having variable period clock where each DTI takes 6.5 nsec, each AI takes 3.75 nsec and each SRI takes 65nsec. Compute the total time required by the benchmark program in variable period clock. [Note: In variable period clock, different class of instructions take different amount of time to execute.]

[6+4 = 10M, CO-2, CO-4]

Q5-a. Consider a hypothetical computer system with the following architectural specifications:

- (i) Machine can support maximum of 1024 different arithmetic and logical operations with each operation having maximum of 64 variants.
- (ii) The register set contains 64K registers with each register capable of holding 64 bits of data.
- (iii) The instruction format of the machine has three register operands: One destination operand and two source operands.
- (iv) Machine has 8GBytes of byte addressable memory.

Construct the instruction format for the above hypothetical computer system. Also, write the size in bits for Instruction Register, Program Counter, MAR and MDR.

Q5-b. Consider a task that requires you to input a line of text from keyboard and display the input line of text on monitor. Write an Assemble Language Program to accomplish the task using Program-Controlled I/O. Make use of the DATA and STATUS registers in your program. Also, comment on how Interrupt Driven I/O performs better than Program-Controlled I/O.

[5+5 = 10M, CO-4, CO-5]



INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, NAGPUR

Department of Computer Science and Engineering
CSL 203: Computer System and Organization
END SEMESTER RE-EXAM

Date: 02/01/2024 (Tuesday)
Time: 8:00 AM to 11:00 AM

Duration: 3 Hours

Semester -III

Max. Marks: 50M

Important Instructions:

- All the questions are compulsory. Write all the subparts of each question together.
- Maximum marks that can be obtained for a particular question are indicated in the brackets [] on the extreme right of the corresponding question.

Q1.a. Consider a fully associative cache memory with 3 lines that implements Least Recently Used (LRU) cache replacement algorithm for the following block requests

7, 0 ,1, 2, 0, 3, 0, 4, 2, 3

- How many misses are there and what is the hit ratio?
- If the number of lines of the fully associative cache are increased to 4, what will be the miss rate and hit rate?

Q1.b. Explain the cache write strategies: Write Through and Write Back? Explain their advantages and disadvantages.

[5+5 =10 M, (CO-3)]

Q2-a.

(i) What is the zero address instruction format? Give an example.

(ii) Enumerate the most commonly used addressing modes of CPU instructions.

(iii) Registers R1 and R2 of a computer contain the decimal values 1200 and 4600. What is the effective address of the memory operand of the instruction: Load 25(R1), R5. [2+1+2=5 M, (CO-1)]

Q2-b. How are the generations of computers classified? Give an overview of evolution of computer architectures from the first to the present generation. [5 M, CO-1]

Q3-a. Give a general expression to evaluate performance of a computer in terms of the number of instructions, operations and the clock frequency. Suggest a few architectural features using which this performance metric could be improved upon. [5 M, CO-5]

Q3-b. Perform multiplication of integers 14 and -7 using Booth's multiplication algorithm. [5 M, CO-4]

Q4-a. What do you mean by hazards and what are the pipelining hazards that occur in a computer architecture? Describe each of them with suitable examples. [5 M, CO-2]

Q4-b. Convert the following pairs of decimal numbers to 5-bit, signed 2's complement binary numbers and perform the following arithmetic operations on them. State whether or not overflow occurs in each case. Convert the result into decimal.

- 10 +12
- 11 + 9
- (-7) - 4
- (-12) - (-14)

[4 M, CO-2]

Q5-a. What is the MIPS assembly code for the following C code?

```
while(save[i] == y)
    i+=1;
```

Assume that i and y correspond to registers \$s3 and \$s5 and the base of the array save is in \$s6. [5 M, CO-4]

Q5-b. Draw the complete combined single cycle datapath diagram for R-type instruction. Also mention the control signals involved in it. [4 M, CO-2]

Q5-c. Find the IEEE standard 754 representation in single precision format for (110.110). Show all steps. [2 M, CO-4]



INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, NAGPUR

Department of Computer Science and Engineering

CSL 204: Discrete Mathematics and Graph Theory

End Semester Exam

Semester - III

Duration: 3 Hours

Date: 29/11/2023 (Thursday)

Time: 09:00 AM to 12:00 PM

Max. Marks: 50 Marks

Important Instructions:

- All the questions are compulsory.
- Maximum marks that can be obtained for a particular question are indicated in the brackets [] on the extreme right of the corresponding question
- Write all the subparts of each question together.

Q. 1A Assume x is a particular real number and use De Morgan's laws to write negations for the following statements. Show your steps. 2 Marks [CO 1]

- A. $-2 < x < 7$ B. $1 > x \geq -3$
 C. $0 \geq x > -5$ D. $-4 < x < -1$

Q. 1B Using standard logical equivalences verify the following statements are logically equivalent or not.

$$(p \wedge (\sim(\sim p \vee q))) \vee (p \wedge q) \equiv p$$

3 Marks [CO 1]

Q. 2A There are 2500 students in a college of these 1700 have taken a course in C, 1000 have taken a course Pascal and 550 have taken course in networking. Further 750 have taken course in both C and Pascal, 400 have taken courses in both C and Networking and 275 have taken courses in both Pascal and Networking. If 200 of these students have taken course in C, Pascal, and Networking.

- How many of these 2500 students have taken courses in any of these three courses C, Pascal and Networking?
- How many of these 2500 students have not taken a course in any of these three courses C, Pascal and Networking.

3 Marks [CO 1]

Q. 2B Let relation R be the relation defined over a set $A = \{1, 2, 3, 4\}$ as mentioned below in matrix form.

I. Find reflexive closure of R

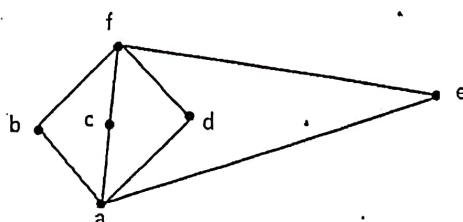
II. Using Warshall's algorithm find transitive closure of R

4 Marks [CO 3]

$$R = \begin{bmatrix} 1 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix}$$

Q. 2C Check whether following lattice is complemented and distributive lattice or not. Justify your answer.

2 Marks [CO 3]



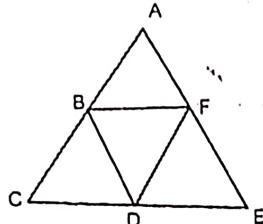
Q. 3A Let G be the set of all 2×2 matrices $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ where a, b, c, d are integer modulo 2, such that

$ad - bc \neq 0$. Using matrix multiplication as the operation in G prove that G is a group of order 6.

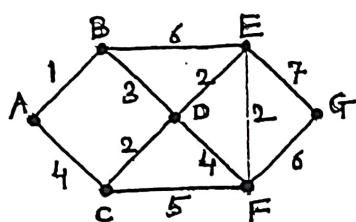
3 Marks [CO 4]

Q. 3B Let X be a nonempty set. Consider power set $R = 2^X$, together with set operations of "Symmetric difference" and "Intersection." Is R Ring? Is R commutative Ring? Justify your answer. 4 Marks [CO 4]

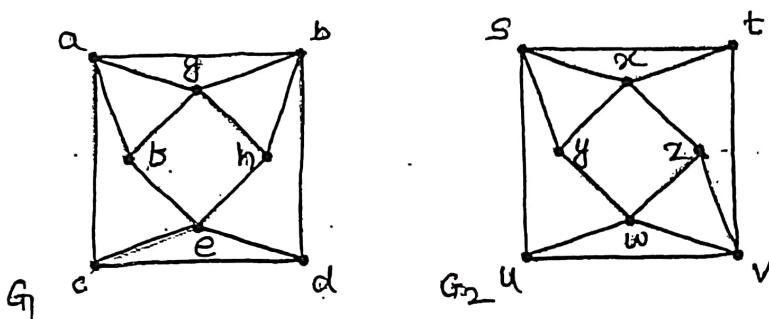
Q. 4A What is the necessary and sufficient condition for the Eulers path to exists in a graph? By following the algorithm find Eulers path in the below graph. Does Euler path exist if you start at any node? Explain. 5 Marks [CO 5]



Q. 4B Using Dijkstra's single source shortest path algorithm, find the shortest path and its cost from Node A to node G in a graph mentioned below. 5 Marks [CO 5]



Q. 4C Determine whether the following graphs $G_1 = (V_1, E_1)$ and $G_2 = (V_2, E_2)$ are isomorphic or not. Give justification. 3 Marks [CO 5]



Q. 5A Solve the recurrence relation $a_n = 7a_{n-1} - 10a_{n-2}$ with initial conditions $a_0 = 2$ and $a_1 = 3$ 5 Marks [CO 5]

Q. 5B Find solution to recurrence relation $x_n = 3x_{n-1} + 10x_{n-2} + 7 \cdot 5^n$ given $x_0 = 4$ and $x_1 = 3$ 5 Marks [CO 5]

Q. 6A Sarah writes down random positive integers when she gets bored. Prove that if Sarah writes 1001 numbers, then there must be at least 2 with the same last three digits. 3 Marks [CO 2]

Q. 6B Form a committee consisting of 6 men and 7 women in how many ways can be selected a committee of
 i) 3 men and 4 women
 ii) 4 members which has at least one woman
 iii) 4 persons of both gender 3 Marks [CO 3]

**Important Instructions:**

- All the questions are compulsory.
- Maximum marks that can be obtained for a particular question are indicated in the brackets [] on the extreme right of the corresponding question
- Write all the subparts of each question together.

Q.1A Given the set $S = \{\{1\}, \{2\}, \{3\}, \{4\}, \{1, 2\}, \{1, 5\}, \{3, 6\}, \{4, 6\}, \{0, 3, 6\}, \{1, 5, 8\}, \{0, 3, 4, 6\}\}$ and the relation, R, being the is a subset of relation. Draw a Hasse Diagram for this partial order. 5 Marks [CO2]

Q.1B Consider the sets $A = \{1, 2, 3\}$, $B = \{x, y\}$, and $C = \{u, v\}$. Let $P(A)$ denote the powerset of A. Find each of the following:

5 Marks [CO 1]

- (a) $P(A \cup B)$
- (b) $P(B \times C)$
- (c) $P(P(C))$
- (d) $A \times (B \cap C)$
- (e) $(A \times B) \times C$

Q.2A To prove this we will show $A \times (B \cup C) \subseteq (A \times B) \cup (A \times C)$ and then $(A \times B) \cup (A \times C) \subseteq A \times (B \cup C)$.

4 Marks [CO 1]

Q.2B A graph has 26 vertices and 58 edges. There are five vertices of degree 4, six vertices of degree 5, and seven vertices of degree 6. If the remaining vertices all have the same degree, what is this degree?

5 Marks [CO 3]

Q.2C Given the following degree sequences either construct a graph with such a degree sequence, or explain why this would be impossible.

6 Marks [CO 3]

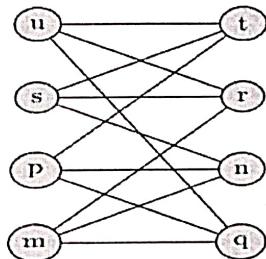
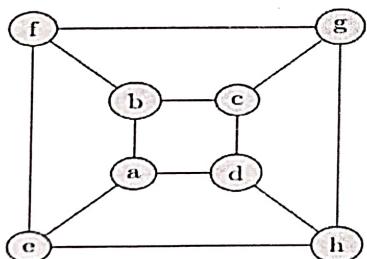
- (a) 1, 1, 1, 1, 1, 1
- (b) 5, 4, 3, 2, 1
- (c) 6, 6, 4, 2, 2, 2, 2, 1

Q.3A Using graph theory, explain whether or not it is possible for each person, in a group of 15 individuals, to have exactly three friends. (Assume that friendship is a symmetric relation, i.e. friendship goes both ways.)

5 Marks [CO 4]

Q.3B Given the following two graphs, write an explicit isomorphism between them

5 Marks [CO 4]



Q. 4A Let G and A be groups and assume that A is abelian. Show that the set $\text{Hom}(G, A)$ of group homomorphisms from G to A is again an abelian group under the multiplication defined by $(f_1 \cdot f_2)(g) := f_1(g)f_2(g)$ for $f_1, f_2 \in \text{Hom}(G, A)$ and $g \in G$.

5 Marks [CO 5]

Q.4B Let H and K be subgroups of a group G . Show that
 $HK \leq G \iff KH = HK$.

5Marks[CO5]

Q.5A Find the solution to $a_n = 7a_{n-2} + 6a_{n-3}$ with $a_0 = 9, a_1 = 10, a_2 = 32$ **5 Marks [CO 5]**

Q.5B Solve the recurrence relation $a_n + a_{n-1} - 6a_{n-2} = 0$ for $n \geq 2$ given that $a_0 = -1$ and $a_1 = 8$.
Here coefficients of a_n, a_{n-1} and a_{n-2} are $c_n = 1, c_{n-1} = 1$ and $c_{n-2} = -6$ respectively. **5 Marks [CO 5]**



INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, NAGPUR

Department of Electronics and Communication

ECL-202: Microprocessors & Interfacing

End Semester Examination

Duration: 3 Hours

Semester – III

Max. Marks: 50

Important Instructions:

1. All questions are compulsory.
2. Assume standard values of data and images if not mentioned in the question.
3. Draw suitable diagram wherever necessary
4. Clearly state the assumptions made while answering.
5. Indicate the important steps of reasoning / calculations.
6. Maximum marks for each question are indicated on the right hand side.

Q1. a) Write a program for the 8085 microprocessor to calculate the sum of two factorials ($a!+b!$). Interface four LEDs to the output port to visually display if the final result is an even or odd number, as well as whether it has even or odd parity. **CO2, [5]**

b) Design a microprocessor 8085 based system and interface the following memory ICs:

- (i) 4K EPROM starting from address 0000H-1 No.
 - (ii) Followed by this 2K of SRAM- 2 Nos.
 - (iii) 256 Bytes of R/W memory starting from address 2000H-1 No.
 - (iv) 2K of SRAM starting from address 2800H-1 No.
 - (v) 4K EPROM starting from address 3000H-1No.
- CO1, [5]**

Use a decoder for chip select logic and additional logic gates may be used if required. Draw the memory map and logic diagram of the system full decoding technique.

Q2. a) Draw and explain the timing diagram of the instruction: LHLD 2500H **CO1, [4]**

b) Design a railway signaling system capable of managing the passage of trains with an average length of 0.5 km at intervals of approximately 1 hour, traveling at a speed of 20 km/hr by utilizing the RST 7.5 interrupt. The system should effectively signal the presence or absence of a passing train using only two lights, namely Red and Green. **CO1, [6]**

Q3. Interface 8 ON/OFF Keys and 8 LED's with 8085 using 8255. Write a program with complete flowchart to read the keys status and reflect it on the LED's connected. Also store the key status into memory location 9000H. **CO4, [10]**

Q4. a) Write a program to generate a rectangular wave having $T_{on}=0.3\text{ ms}$ and $T_{off}=0.6$ using SOD pin of 8085. **CO3, [5]**

b) Design an up-down counter using 8254 IC to count from 0 to 9 and 9 to 0 continuously, with a 1.5 second delay between each count and display the count at one of the output port. Draw the flowchart and write a program for the given task. Also, calculate the delay if the microprocessor frequency is 3 MHz. **CO5, [5]**

Q5. a) Explain the function and addressing modes of the following 8086 microprocessor instructions: **CO1, [5]**

(i) XLAT (ii) POPF (iii) AAA (iv) INC (v) XCHG

b) Write an 8086 microprocessor assembly language program to move a byte string 16 byte long from the offset 0200H to 0300H in the segment 7000H. **CO2, [5]**



INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, NAGPUR

Department of Electronics and Communication

ECL-202: Microprocessors & Interfacing

End Semester Re-Examination

Duration: 3 Hours

Semester – III

Max. Marks: 50

Important Instructions:

1. All questions are compulsory.
2. Assume standard values of data and images if not mentioned in the question.
3. Draw suitable diagram wherever necessary
4. Clearly state the assumptions made while answering.
5. Indicate the important steps of reasoning / calculations.
6. Maximum marks for each question are indicated on the right hand side.

- Q1. a) Write a program for 8086 microprocessor to move the contents of the memory location 0500H to register BX and to CX. Add immediate byte 05H to the data residing in memory location whose address is computed using DS=2000H and offset=0600H. Store the result of the addition in 0700H. Assume that the data is located in the segment specified by the data segment register DS which contain 2000H. CO2, [5]
- b) Connect 2 kB EPROM one IC, 2kB expansion socket for RAM one number, 2kB RAM two ICs. Generate \overline{MRD} and \overline{MWR} signals using OR gate. CO1, [5]
- Q2. a) Explain the function and addressing modes of the following 8086 microprocessor instructions:
(i) ADC (ii) CMP (iii) DEC (iv) AAS (v) RCL CO1, [5]
- b) Point out the differences between the following 8085 instructions:
i. CALL and Return
ii. Push and Pop
iii. Conditional call and unconditional call. CO1, [5]
- Q3. a) Write a program to generate a square wave having $T_{on}=0.5$ ms and $T_{off}=0.5$ ms using SOD pin of 8085. CO3, [5]
- b) Design a pulse train generator for a frequency 1kHz and duty cycle of 25% using 8254. Assume suitable clock frequency. CO5, [5]
- Q4. Interface one input device with microprocessor 8085 by using 8255 PPI. The input device has one input pin RUN which when made active, then the input device will output the data at synchronous speed. Write an ALP to make the device ON, input and store 100 bytes into memory from 9000H and then make the device OFF. CO4, [10]
- Q5. a) Draw and explain the timing diagram of the instruction: LXI H, 2500H CO1, [5]
- b) Write a program for 8085 microprocessor to find the smallest number in a given array of 10 elements. The array is stored in the memory from 9200H onwards. Store the result at the memory location 9300H. The length of the array should be defined as the first element and then the data starts. CO2, [5]



INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, NAGPUR

Department of Computer Science & Engineering

CSL202: Introduction to Object Oriented Programming

End Semester Exam

Duration: 3 hours

Semester – III (CSE, AIML, DSA, HCIGT), V(ECE) Max. Marks: 60

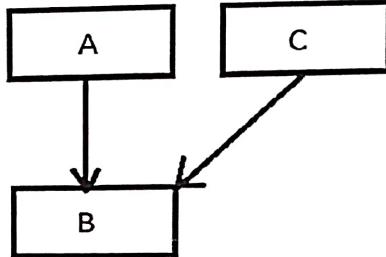
Date: Dec 1, 2023 (Fri)

Important Instructions:

- This is a closed book, closed notes examination.
- This question paper comprises total 5 questions.
- All the questions are compulsory.
- Write all the subparts of a question together.

| | | |
|-------------|--|-----------------------|
| Q.1 (a) | <p>Assume that a person, X likes Movies, and Songs. Whenever X downloads Movies, or Songs from the internet, he keeps them in different folders. There is another person, Y, who likes Games and E-books. Y downloads them to different folders. Assume that a person, Z likes Movies, Songs, Games as well as E-books. Elaborate as to how Java concepts can be used to capture interests of X, Y and Z.</p> <p>Following information should be considered for the entities, namely Movies, Songs, Games and E-books.</p> <ul style="list-style-type: none">• Movies: Movie Name, Movie Release Year, Type of Movie• Songs: Song Name, Song Release Year, Type of Song• Games: Name of the Game, Game Release Year, Type of Game• E-books: Name of the e-book, Type of e-book• Operations to add /delete Movies, Songs, Games and E-books and display operation. <p>Write a program in Java to solve the above problem.</p> | (8M) [CO1, CO4] |
| (b) | <p>Let, A, B, C, and D be four classes like below.</p> <pre>graph TD; A[A] --> B[B]; A --> C[C]; B --> D[D]; C --> D;</pre> <p>Now let, there are two functions: Addition() and Subtraction(). In the main program, we try to create the object of class D. We want to use the Addition() and Subtraction() functions while creating the object of class D. Write the pseudocode in C++ to solve the above problem with the following given conditions:</p> <ol style="list-style-type: none">i) When Addition() and Subtraction() functions are defined only in class A.ii) When Addition() and Subtraction() functions are defined only in class B and class C.iii) When Addition() and Subtraction() functions are defined only in class A, class B and class C. | (4M) [CO1, CO2] |
| Q. 2 (a) | <p>Write a program in java where task related details need to be maintained. Create a file "Task.txt" which contains task details such as description of a task, due date and completion status. The program provides following options to the user as: to add new tasks, mark tasks as completed, view pending tasks, generate a summary report, and exit the program. The file is read and written line by line without loading the entire dataset into memory. Updating the task requires reading the file, searching relevant lines, then updating the task and rewriting the entire file.</p> | (8M) [CO1, CO4] |
| (b) | Assume that the following diagram is given below where not all of A, B, and C are classes, some may be interfaces | (4M) [CO1, CO2, |

CO3]

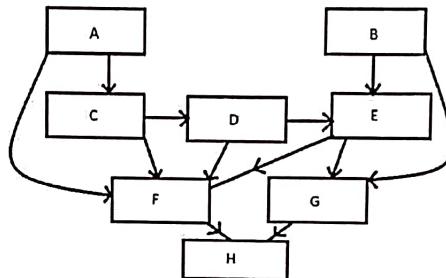


Then, find which statement/s is/are not true in Java with proper explanation.

- i) All A, B, and C's are interfaces.
- ii) A and B are classes, and C is the interface.
- iii) C and B are classes, and A is the interface.
- iv) A and C are interfaces, and B is the class.
- v) A and C are classes and B is the interface.

Q.3
(a)

Assume that you have been given the following diagram:

(4M)
[CO1,
CO2,
CO3]

Here, A, B, D, and H are classes. Here, class A is inherited by classes C and F, and so on. Assume that class A has two functions: Addition() and Subtraction(), whereas class B has two functions: Multiplication() and Subtraction() and class D has one function: Division(). In the main program, we create the object of class H. We want to use the Addition(), Subtraction(), Multiplication() and Division() functions. Then write the pseudocode in Java with the following conditions below.

- a. If we don't redefine any functions in class H.
- b. If we redefined some functions in class H.

(b)

Write the output and/ or error with a proper explanation.

```

#include <iostream>
using namespace std;

template <typename T>
void fun(const T&x)
{
    static int count = 0;
    cout << "x = " << x << " count = " << count << endl;
    ++count;
    return;
}

int main()
{
    fun<int>(1);
    cout << endl;
    fun<int>(1);
    cout << endl;
    fun<double>(1.1);
    cout << endl;
    fun<double>(1.1);
    cout << endl;
}
  
```

(4M)
[CO1,
CO2,
CO3]

| | | |
|-----|---|---|
| | <pre> fun<int>(1.5); cout<<endl; fun< int>(1.1); cout<<endl; return 0; } </pre> | |
| (c) | <p>Write the output and/ or error with proper explanation.</p> <pre> #include <iostream> using namespace std; template <int i> void fun() { i = 10; cout<<i; i = 10.5; cout<<i; i = 'c++'; cout<<i; } int main() { fun<10>(); return 0; } </pre> | (4M) [CO1, CO2, CO3] |
| Q.4 | <p>Write a Java program with the following requirements.</p> <ul style="list-style-type: none"> • Create an interface, named “ICharQ” for a character queue having put and get methods. • There should be two different classes which should implement ICharQ. One class, namely FixedQueue should implement a character queue of a fixed size • Another class, namely DynQueue should implement a dynamic character queue, which grows as necessary when its size is exceeded.. • Also, write a driver code in a class, namely IQDemo that demonstrates both the queues. <p>Note that both implementations of this character queue should use an array to store the characters</p> | (3M) (3M) (3M) (3M) [CO1, CO2, CO3] |

| | | |
|-----|---|-----------------------|
| Q.5 | <p>Design a simple Java program for a calculator that can perform basic arithmetic operations (addition, subtraction, multiplication, and division) on two numbers entered by the user. Implement proper exception handling to deal with potential issues such as division by zero and invalid input.</p> <p>Requirements: The program should take two numbers and an operator (+, -, *, /) as input from the user.</p> <p>Implement try-catch blocks to handle the following exceptions:</p> <ul style="list-style-type: none"> • DivideByZeroException: If the user attempts to divide by zero, catch the exception and display an error message (user defined). (3M) • InputMismatchException: If the user inputs a non-numeric value, catch the exception and display an error message. (3M) • InvalidOperatorException: If the user enters an invalid operator, catch the exception and display an error message (user defined). (3M) • Perform the selected arithmetic operation and display the result if there are no exceptions. (3M) <p>Your task is to implement this calculator program with proper exception handling. Additionally, provide meaningful error messages for each exception case.</p> | [CO1, CO3, CO4] |
|-----|---|-----------------------|



INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, NAGPUR

Department of Computer Science & Engineering

CSL202: Introduction to Object Oriented Programming

Date: Jan-4, 2024 (Thu)

Re-Exam

Duration: 3 hours

Semester – III (CSE, AIML, DSA, HCIGT), V(ECE) Max. Marks: 60

Important Instructions:

- This is a closed book, closed notes examination.
- This question paper comprises of total 6 questions.
- All the questions are compulsory. Write all the subparts of a question together.

| Q.1 | Describe in detail different features of Object-Oriented Programming. | (10M) [CO1, CO4] | | | | | | | | | | | | | | | |
|------------------|---|--------------------------------|------|------|-----------|------|--------|------------------|-------|--------|-------|-------|-------|-------|-------|-------|--------------------------------|
| Q. 2 | Design three classes, namely Student, Test, Results, where class Results is inherited from class Test and class Test is inherited from class Student. Write possible functions to initialize the value by creating objects in Java and an appropriate display functions. Also elaborate different types of Inheritances. | (10M) [CO1, CO4] | | | | | | | | | | | | | | | |
| Q.3 | <p>Write a program in C++ to read a list containing item name, item code, and cost interactively and produce a three-column output as shown below.</p> <table><thead><tr><th>Name</th><th>Code</th><th>Cost</th></tr></thead><tbody><tr><td>Turbo C++</td><td>1001</td><td>350.90</td></tr><tr><td>Java Programming</td><td>12345</td><td>500.50</td></tr><tr><td>-----</td><td>-----</td><td>-----</td></tr><tr><td>-----</td><td>-----</td><td>-----</td></tr></tbody></table> <p>Note that the name and code are left-justified and cost is right-justified with a precision of two digits. Trailing zeros are shown. Use File Handling.</p> | Name | Code | Cost | Turbo C++ | 1001 | 350.90 | Java Programming | 12345 | 500.50 | ----- | ----- | ----- | ----- | ----- | ----- | (10M) [CO1, CO2, CO3] |
| Name | Code | Cost | | | | | | | | | | | | | | | |
| Turbo C++ | 1001 | 350.90 | | | | | | | | | | | | | | | |
| Java Programming | 12345 | 500.50 | | | | | | | | | | | | | | | |
| ----- | ----- | ----- | | | | | | | | | | | | | | | |
| ----- | ----- | ----- | | | | | | | | | | | | | | | |
| Q.4 | <p>Describe in details</p> <ul style="list-style-type: none">(i). Abstract class in Java(ii). Interfaces in Java(iii). Virtual function in C++(iv). Function overloading in C++(v). Operator overloading in C++ | (10M) [CO1, CO2, CO3] | | | | | | | | | | | | | | | |
| Q.5 | <p>On the occasion of Christmas holiday you are planning to go to funland but this park is at a considerable distance so you are going to check tickets criteria online. Go to “PROogramology” site of park where you will enter the number of persons going, hours you will stay there and swing you goanna choose. Furthermore, the rates for discovery are as follows.</p> <ul style="list-style-type: none">(i). Children below Age 10 are not allowed to sit on discovery.(ii). Age 10-15 wins 10 % discount.(iii). Age 15-20 wins 5% discount.(iv). No discount for children with Age above 20. <p>The rates for maryland swingare as follows.</p> <ul style="list-style-type: none">(i). Age 1-5 yrs. wins 50 % discount. | (10M) [CO1, CO2, CO3] | | | | | | | | | | | | | | | |

| | | |
|-----|---|---|
| | <p>(ii). Age 5-10 yrs. wins 25% discount.</p> <p>(iii). No discount for Age above 10.</p> <p>Write a program in C++ that will ask to enter age of person and will run until you enter the age of last family member. The program will then tell you the amount due after each person's age you enter. Also, the parking fee is given as INR 10/hour and the price of ticket is INR 100.</p> | |
| Q.6 | <p>Elaborate the different types of exceptions in Java with examples.</p> <p>Also, elaborate the terms final and finally in Java with examples.</p> | <p>(6M)</p> <p>(4M) [CO1, CO2, CO3]</p> |



CSA

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, NAGPUR

Department of Basic Sciences

Introduction to Entrepreneurship (HUL 103)

End Semester Examination

Duration: 3 Hour

Semester- III (CSE-AIML)

Marks: 60

Date: 4.12.2023

Time: 9AM – 12PM

Important Instructions:

- This question paper contains total 8 questions. All questions are compulsory.
-

Q.1 Entrepreneurs need to be concerned with formally evaluating an idea throughout its evolution. Care must be taken to be sure that idea can be the basis for a new venture. This can be done through careful evaluation that results into go or no-go decision at each of the stages of the product planning and development process. Design your own product/service on the basis of six stages of Product/Service Development process in entrepreneurship. **(10 Marks) (CO5)**

Q.2 By 2010, the FieldFresh team had been able to create an efficient supply chain for baby corn across Punjab and Maharashtra at all levels. But success brought with it the expectation of growth. Should FieldFresh grow opportunistically into different foreign markets as retailers and wholesalers demanded different products for their respective markets? Should FieldFresh continue to focus on baby corn, whose supply chain-market linkages it had perfected, or should the company expand the range of products it would supply? Should FieldFresh continue to maintain its primary export focus, or shift relative emphasis to the growing domestic market? Justify your answer. **(10 Marks) (CO5)**

Q.3 Entrepreneurship is the ability and readiness to develop, organize and run a business enterprise, along with any of its uncertainties in order to make a profit. The most prominent example of entrepreneurship is the starting of new businesses. Elaborate upon the concept of entrepreneurship along with its characteristics. Also provide the classification of entrepreneurship. What factors influences the entrepreneurship? Discuss the obstacles to entrepreneurship. **(10 Marks) (CO1)**

Q.4 In today's modern society, businesses have been gaining more power and it invariably influences various areas of our society. Thereby, businesses are obliged to take the responsibility for the upholding of values, wealth creation, and the appropriateness of the tools that are used to achieve the goals. In this regard, critically examine role of values & ethics in entrepreneurship development. What are the most common ethical issues faced by entrepreneurs? Also discuss "Entrepreneurship as a triangle of values". **(10 Marks) (CO3)**

Q.5. Before entering the Yale School of Management, James Guba had thought about becoming an entrepreneur. He did not have a specific idea to build a business around, but he did aspire to take charge of an organization and grow it. At Yale, Guba discovered an entrepreneurial niche called "search funds" that would allow him to acquire and lead a company that he had not built from scratch. Inspired, Guba met with search fund entrepreneurs to learn about their different paths to building their funds. In the context of above case, discuss the concept of business incubation. Elaborate upon the services offered by business incubators. **(5 Marks) (CO5)**

Q.6 MSMEs are known as the lifeline of an economy, which is very important for a country like India. What are the objectives of MSMEs? Discuss the importance of MSME for Indian economy. **(5 Marks) (CO4)**

Q.7 Write a short note on following with appropriate examples.

a. Sources of Business Idea

(5 Marks) (CO5)

b. McGregor's Theory X and Theory Y

(5 Marks) (CO2)



End Semester Exam

Duration: 3 hour

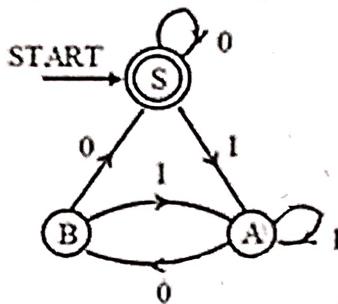
Semester-III

Max. Marks:60

Important Instructions:

- This is a closed book, closed notes examination.
- All questions are compulsory.
- Maximum marks that can be obtained for a particular question are indicated in the brackets [] on the extreme right of the corresponding question

1. a) Construct the deterministic finite automata for the language over $\Sigma = \{a, b\}$ and is defined [5] CO1 as:
 $L = \{ w \mid w \text{ not containing aba as substring} \}$
- b) Prove the following statements: [5] CO1
- If NFA without ϵ -moves contains N no. of states then its equivalent DFA contains maximum of 2^N states.
 - Every DFA is an NFA.
2. a) Convert the given automata to equivalent regular expression: [3] CO2



- b) Let $\Sigma = \{a, b\}$. Give a CFG generating all the language of strings with twice as many a's as b's. [2] CO2
- c) Discuss Universal Turing Machine. [2] CO1
- d) Give the regular expression for the following language where $\Sigma = \{0, 1\}$: [3]
- $L_1 = \{w \mid w \text{ contains at least two 0s or at most one 1}\}$
 - $L_2 = \{w \mid w \text{ contains an even number of 0s or contains exactly two 1s}\}$
- .a) Design a Turing Machine to compute $f(m,n)=m+n$, that is addition of two integers. Construct the TM as discussed in class. Also, simulate one string by the constructed TM. [6] CO1
- b) Prove that the language $L = \{0^n 1^n 2^n \mid n \geq 0\}$ is not context-free using pumping lemma. [4] CO1
- 4.a) A. Consider the C expression: [2+3] CO3
 $A = C + B * D$

Identify the token names and associated attribute values that will be generated by the lexical analyzer.

B. Consider that a lexical analyzer uses the following pattern for tokens,

digit → [0-9]
 digits → digit +
 number → digits (. digits)? (E [+ -]? digits)?

- b) Construct the transition diagram that recognizes an unsigned number. [5] CO4
- b) Write LL(1) parsing table for the following grammar:

$$S \rightarrow b\ r \mid a \mid b\ A\ r$$

$$A \rightarrow S \mid A\ c\ S$$

Parse the string "bbarr".

5. a) Find First() and Follow() for the following Grammar:

[5] CO3

$$S \rightarrow PQp \mid qRP$$

$$P \rightarrow rQRS \mid \epsilon$$

$$Q \rightarrow RsP \mid ps$$

$$R \rightarrow tR \mid \epsilon$$

$$S \rightarrow qSu \mid p$$

- b) Consider the following grammar:

[5] CO4

$$A \rightarrow abA \mid \epsilon \mid \text{ERROR}$$

$$\text{ERROR} \rightarrow a \mid bX \mid aaX$$

$$X \rightarrow aX \mid bX \mid \epsilon$$

A. Which strings the grammar generates starting from A?

B. Write syntax directed scheme such that if parse tree of the string has ERROR non-terminal, then the root node prints "Unacceptable" else it prints "Acceptable".

6. a) Consider the following grammar,

[1+2+] CO4

1]

$$A \rightarrow AA$$

$$A \rightarrow (A)$$

$$A \rightarrow a$$

A. Is the grammar ambiguous? Justify.

B. If bottom-up parsing is used to parse the string "a(a)aa", then show the handle at every step of parsing.

C. Can we use ambiguous grammar for bottom-up parsing? Justify.

- b) Consider the following grammar

[6] CO4

$$S \rightarrow a\ A\ d \mid a\ c\ e \mid b\ A\ e$$

$$A \rightarrow c$$

Construct the SLR(1) parsing table for this grammar. Is this grammar SLR(1)?



Re-End Semester Exam

Duration: 3 hour

Semester-III

Max. Marks:60

Important Instructions:

- This is a closed book, closed notes examination.
- All questions are compulsory.
- Maximum marks that can be obtained for a particular question are indicated in the brackets [] on the extreme right of the corresponding question

1. a) Consider the grammar $G = (V, \Sigma, R, S)$ where [2 + 3] CO1

$$V = \{a, b, S, A\},$$

$$\Sigma = \{a, b\},$$

$$R = \{S \rightarrow AA,$$

$$A \rightarrow AAA,$$

$$A \rightarrow a,$$

$$A \rightarrow bA,$$

$$A \rightarrow Ab\}$$

- Which strings of $L(G)$ can be produced by derivation of four or fewer than four steps?
- Derive the string “babbab” using right-most and left-most derivation.

b) Construct a nondeterministic finite automaton to accept the language represented by the [5] CO1 following regular expression:

- $(ab + aba)^* a)^*$
- $((ab)^* + (bc)^*) ab$

2. a) A language L is **definite** if there is some k such that, for any string w , [1+2+ 4] CO1 whether $w \in L$ depends only on the last k symbols of w .

- Rewrite this definition more formally.
- Show that every definite language is accepted by a finite automaton.
- Show that the class of definite languages is closed under union and complementation.

b) State true or false with justification: [3] CO2

- Every subset of regular language is regular.
- $\{w \mid w = w^R\}$ is regular.

3.a) Show that the following language is not context free using pumping lemma: [4] CO1

$$L = \{a^p \mid p \text{ is a prime}\}$$

b) Convert the following PDA to CFG: [6] CO2

$$P = (\{p, q\}, \{0, 1\}, \{X, Z_0\}, \delta, q, Z_0)$$

$$\delta(q, 1, Z_0) = \{(q, XZ_0)\}.$$

$$\delta(q, 1, X) = \{(q, XX)\}.$$

$$\delta(q, 0, X) = \{(p, X)\}.$$

$$\delta(q, \epsilon, X) = \{(q, \epsilon)\}.$$

$$\delta(p, 1, X) = \{(p, \epsilon)\}.$$

$$\delta(p, 0, Z_0) = \{(q, Z_0)\}.$$

4.a) In the following context-free grammar, [2+3] CO4

Design PDA for $L = 1^n 0 1^n$ such
n is greater than = 1

$E \rightarrow 10^*T \mid 5+T$
 $T \rightarrow PS$
 $S \rightarrow QP \mid \epsilon$
 $Q \rightarrow + \mid *$
 $P \rightarrow a \mid b \mid c$

- a. Check whether the grammar is LL(1) or not. Give proper justification.
- b. Construct the LL(1) parsing table.
- b) "Code Optimization is an optional phase of compilation process". Is this true? Justify. [2] CO3
- c) Construct LR(0) automata for the following grammar: [3] CO4

$S \rightarrow AA$
 $A \rightarrow aA \mid b$

- 5 For the following grammar: (All digits are terminals) [6+1+ CO4
3]

$S \rightarrow SS \mid AB$
 $A \rightarrow 9 \mid AB$
 $B \rightarrow 3$

- i. draw the LALR(1) parsing table.
ii. Give the smallest string recognized by the above grammar.
iii. Parse the same using the table.

- 6.a) Compute the FIRST() and FOLLOW() set for each nonterminal of the grammar given [5] CO4 below:

$S \rightarrow ABa \mid bCA$
 $A \rightarrow cBCD \mid \epsilon$
 $B \rightarrow CdA \mid ad$
 $C \rightarrow eC \mid \epsilon$
 $D \rightarrow bSf \mid a$

- b) Consider the following program: [5] CO3

```

#include <stdio.h>
int main() {
    int i = 1;

    while (i <= 5) {
        printf("%d\n", i);
        ++i;
    }

    return 0;
}

```

List the lexemes and tokens generated at the end of the lexical analysis of the above program.

CSD

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, NAGPUR

Department of Basic Sciences

Advanced Probability and Statistics (MAL202)

End Semester Examination

B.Tech. 3rd Semester - DSA

Duration: 3 hour

Max. Marks: 60

Date: November 23rd, 2023 (Thursday)

Time: 09:00 AM to 12:00 PM

Important Instructions:

- (i) This is a closed book, closed notes examination.
- (ii) This question paper comprises total 5 questions printed on three pages. All questions are compulsory. Maximum marks for a particular question are indicated on the extreme right of the corresponding question.
- (iii) Use of non-programmable calculator is permitted.
- (iv) Please indicate the important steps of reasoning/calculations carefully.
- (v) Assume suitable data wherever necessary. Please mention the assumptions made, if any.

- Q.1(a)** Define sample variance, sample covariance and the sample covariance matrix. The students percentage of marks in Physics (P), Mathematics (M), and English (E) is given in the Table. Find the sample covariance matrix for the data given in the table.

| Roll No. | 1 | 2 | 3 | 4 | 5 | 6 |
|-------------|----|----|----|----|----|----|
| Physics | 78 | 36 | 98 | 25 | 75 | 82 |
| Mathematics | 84 | 51 | 91 | 60 | 68 | 62 |
| English | 81 | 44 | 95 | 43 | 72 | 72 |

[CO-1], [4]

- (b)** Define linear combination of the variables. Suppose $\mathbf{Y} = [y_1 \ y_2 \ y_3]'$ is distributed as $N_3(\mu, \Sigma)$, where

$$\mu = \begin{bmatrix} 36.09 \\ 25.55 \\ 34.09 \end{bmatrix} \text{ and } \Sigma = \begin{bmatrix} 65.09 & 33.65 & 47.59 \\ 33.65 & 46.07 & 28.95 \\ 47.59 & 28.95 & 60.69 \end{bmatrix}$$

(i) For the vector $\mathbf{a} = [3 \ -2 \ 4]'$, find the mean of $z = \mathbf{a}'\mathbf{Y}$.

(ii) Let $\mathbf{b} = [1 \ 3 \ -1]'$, and $w = \mathbf{b}'\mathbf{Y}$. Find the mean and variance of w .

Also, for $\mathbf{c} = \begin{bmatrix} w \\ z \end{bmatrix}$, find the sample mean vector $\bar{\mathbf{c}}$ and the sample covariance matrix of \mathbf{c} .

- (c)** Table 1 contains information of blood glucose levels on two occasions of the four patients. The y 's represent fasting glucose measurement on two occasions; the x 's are glucose measurements one hour after sugar intake. The covariance matrix for all the six variables is given by $S = \begin{pmatrix} S_{yy} & S_{yx} \\ S_{xy} & S_{xx} \end{pmatrix}$. Find S_{xy} .

| Fasting | | One hour after sugar intake | |
|---------|-------|-----------------------------|-------|
| y_1 | y_2 | x_1 | x_2 |
| 73 | 68 | 90 | 122 |
| 72 | 83 | 69 | 96 |
| 65 | 60 | 94 | 89 |
| 52 | 70 | 94 | 100 |

[CO-1], [4]

- Q.2(a) The sample of 10 observations distributed as $N_3(\mu, \Sigma)$. Test the hypothesis $H_0 : \mu = [15 \ 6 \ 2.85]'$ using multivariate T^2 test. Given $T_{C:0.05,3,9}^2 = 16.766$, sample mean vector $\bar{y} = \begin{bmatrix} 28.1 \\ 7.18 \\ 3.09 \end{bmatrix}$, and sample covariance matrix $S = \begin{bmatrix} 140.54 & 49.68 & 1.94 \\ 49.68 & 72.25 & 3.68 \\ 1.94 & 3.68 & 0.25 \end{bmatrix}$. [CO-2], [4]

- (b) The sample of seven observations is distributed as $N_3(\mu, \Sigma)$.

The sample mean vector and the sample covariance matrix are

as follows:

$$\bar{y} = \begin{bmatrix} 14.01 \\ 2.21 \\ 3.08 \end{bmatrix}, \quad S = \begin{bmatrix} 45.54 & 4.69 & 2.33 \\ 4.69 & 72.25 & 15.23 \\ 2.33 & 15.23 & 0.25 \end{bmatrix}.$$

The two observations of the sample are given in the table.

Check whether the observations are outliers or not. Given:

$$D_{c:0.05,3,6}^2 = 4.14.$$

- (c) For the data given in the table, fit a multiple regression model of Y on X_1 and X_2 . Also, interpret the result.

| | | | | | | | | | | |
|-------|---|---|---|---|---|---|---|---|---|---|
| Y | 3 | 7 | 2 | 1 | 6 | 2 | 8 | 3 | 9 | 2 |
| X_1 | 4 | 9 | 3 | 1 | 3 | 4 | 7 | 3 | 8 | 1 |
| X_2 | 2 | 7 | 1 | 2 | 3 | 4 | 9 | 2 | 7 | 3 |

| Observation | y_1 | y_2 | y_3 |
|-------------|-------|-------|-------|
| O_1 | 40 | 30 | 4.38 |
| O_2 | 6 | 2.7 | 2.73 |

[CO-2], [4]

[CO-2], [4]

- Q.3(a) Samples of steel produced at two different rolling temperatures are compared in Table. The variables are y_1 = yield point and y_2 = ultimate strength. From the data, calculate mean vectors, pooled variance matrix S_{pl} , and the discriminant function. Also, find the discriminant score for each individual case of the Temperature 1 and Temperature 2.

| Temprature 1 | | Temprature 2 | |
|--------------|-------|--------------|-------|
| y_1 | y_2 | y_1 | y_2 |
| 33 | 60 | 35 | 57 |
| 36 | 61 | 36 | 59 |
| 35 | 64 | 38 | 59 |
| 38 | 63 | 39 | 61 |
| 40 | 65 | 41 | 63 |
| | | 43 | 65 |
| | | 41 | 59 |

[CO-3], [6]

- (b) The sample covariance matrix for the three dimensional data is given by $S = \begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$

[CO-3], [6]

Find the principle components.

- Q.4(a) Define (i) Unbiased estimator, (ii) Positively biased estimator, (iii) Negatively biased estimator and (iv) Asymptotically unbiased estimator. If x_1, x_2, \dots, x_n be random sample of size n from a normal distribution with mean \bar{x} and variance σ^2 , show that the statistic $s^2 = \frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^2$ is not an unbiased estimator of the parameter σ^2 . Further show that it is asymptotically unbiased estimator of the parameter σ^2 . [CO-4], [4]

- (b) Smith is in jail and has 3 dollars; he can get out on bail if he has 8 dollars. A guard agrees to make a series of bets with him. Each time Smith bets 1 dollar. The Smith's probability of winning 0.4 and that of losing is 0.6. He could not bet if he has no dollars. If his fortune reaches to 8 dollars, he will stop betting.

(i) Denoting the states by 0, 1, 2 and so on, draw the transition diagram of the Markov chain.

Is the Markov Chain irreducible?

(ii) Compute the transition probability matrix.

(iii) Find $p(X_4 = 3, X_3 = 4, X_2 = 5, X_1 = 4, X_0 = 3)$.

[CO-4],[4]

- (c) Let $(X_n, n \geq 0)$ be a homogeneous Markov chain with transition probability matrix $P = (p_{ij})$, and n -step transition probability matrix $P^{(n)} = (p_{ij}^{(n)})$, where $p_{ij}^{(n)} = p(X_n = j | X_0 = i)$ and $p_{ij}^{(1)} = p_{ij}$. Then prove that $P^{(n)} = P^n$ that is n -step transition probability matrix $P^{(n)}$ is equal to the n^{th} power of the one step transition probability matrix P .

[CO-4],[4]

- Q.5(a) Define likelihood function and sufficient estimator. Show that in estimating for the parameter μ in the Poisson distribution with general term

$$\frac{e^{-\mu}}{x!} \mu^x$$

\bar{x} is the sufficient estimator for μ .

[CO-5], [6]

- (b) Define maximum likelihood estimator. Given the frequency function

$$f(x, \theta) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}(x-\theta)^2/\sigma^2}$$

find the maximum likelihood estimator of θ based on a sample of size n .

[CO-5], [6]

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, NAGPUR

Department of Basic Sciences

Advanced Probability and Statistics (MAL202)

End Semester Re-Examination

B.Tech. 3rd Semester - DSA

Duration: 3 hour

Max. Marks: 60

Date: January 1st, 2024 (Monday)

Time: 08:00 AM to 11:00 AM

Important Instructions:

- (i) This is a closed book, closed notes examination.
- (ii) This question paper comprises total 5 questions printed on two pages. All questions are compulsory. Maximum marks for a particular question are indicated on the extreme right of the corresponding question.
- (iii) Use of non-programmable calculator is permitted.
- (iv) Please indicate the important steps of reasoning/calculations carefully.
- (v) Assume suitable data wherever necessary. Please mention the assumptions made, if any.

Q.1(a) Suppose y is distributed as $N_2(\mu, \Sigma)$, where $\mu = \begin{pmatrix} 4 \\ -2 \end{pmatrix}$, $\Sigma = \begin{pmatrix} 5 & 4 \\ 4 & 1 \end{pmatrix}$, and $y = \begin{pmatrix} y_1 \\ y_2 \end{pmatrix}$.

- (a) Find the distribution of $z = 2y_1 - 4y_2$.
- (b) Find the joint distribution of $z_1 = 4y_1 + 2y_2$ and $z_2 = -2y_1 + y_2$.
- (c) Find the joint distribution of $\frac{y_1+y_2}{2}$.

[CO1][6 Marks]

- (b) For the data given below, find the covariance matrix for all three variables. [CO1][6Marks]

| Case | y_1 | y_2 | y_3 |
|------|-------|-------|-------|
| 1 | 6 | 2.7 | 2.73 |
| 2 | 20 | 2.8 | 2.81 |
| 3 | 35 | 4.6 | 2.88 |
| 4 | 35 | 10.9 | 2.9 |
| 5 | 35 | 8 | 3.28 |

Q.2(a) Let the sample of 20 observations originated from the bivariate normal $N_2(\mu, \Sigma)$, where $\Sigma = \begin{bmatrix} 0.4 & 2 \\ 2 & 20 \end{bmatrix}$. Test the hypothesis $H_0 : \mu = [1.4 \ 3.4]'$ for 5% level of significance. Given $\bar{y}_1 = 1.43$, $\bar{y}_2 = 3.3$ and $\chi^2_{0.05,2} = 5.99$. [CO2][6Marks]

(b) Sample S_1 of nine observations is distributed as $N_3(\mu_1, \Sigma_1)$ with mean vector $= [48.61 \ 52.67 \ 11.05]^T$. Sample S_2 of 10 observations is distributed as $N_3(\mu_2, \Sigma_2)$ with mean vector $= [88.67 \ 52.22 \ 17.44]^T$.

The covariance matrices for the two samples are respectively given as

$$S_1 = \begin{bmatrix} 289.67 & 12.04 & 44.36 \\ 12.04 & 21.57 & 8.08 \\ 44.36 & 8.08 & 28.40 \end{bmatrix} \text{ and } S_2 = \begin{bmatrix} 870.4 & -113.278 & 25.11 \\ -113.278 & 119.83 & -5 \\ 25.11 & -5 & 8.6 \end{bmatrix}.$$

Test the hypothesis $H_0 : \mu_1 = \mu_2$ using multivariate T^2 test. Given $T^2_c : 0.05, 3, 17 = 11.117$.

[CO2][6Marks]

Q.3(a) For the data given below,

[CO3][6Marks]

(a) Find the discriminant function.

(b) Also find the discriminant scores for the means of the two groups and the grand mean.

| Customer | Evaluation | X_1 | X_2 | Customer | Evaluation | X_1 | X_2 |
|----------|------------|-------|-------|----------|------------|-------|-------|
| 1 | No | 2 | 6 | 6 | Yes | 7 | 4 |
| 2 | No | 3 | 4 | 7 | Yes | 8 | 2 |
| 3 | No | 4 | 9 | 8 | Yes | 9 | 5 |
| 4 | No | 5 | 8 | 9 | Yes | 10 | 4 |
| 5 | No | 6 | 9 | 10 | Yes | 11 | 7 |

(b) The sample covariance matrix for the three dimensional data is given by $S = \begin{bmatrix} 2 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 2 \end{bmatrix}$

Find the principle components.

[CO3][6Marks]

Q.4(a) Let $S = \{s_0, s_1, \dots, s_t\}$ be the state space and X_t denotes the state at time t . prove that

$$P(X_t = s_t, X_{(t-1)} = s_{(t-1)}, \dots, X_0 = s_0) = p_{s_{(t-1)}s_t} \times p_{s_{(t-2)}s_{(t-1)}} \times \dots \times p_{s_0s_1} \times q_0(s_0)$$

where, p_{ij} be the probability of transition from state i to state j , and $q_0(s_0)$ be the initial probability of the state s_0 .

[CO4][6Marks]

(b) Given that a person last cola purchase was Coke, there is a 90% chance that his next cola purchase will also be Coke. If the person last cola purchase was Pepsi, there is a 80% chance that his next cola purchase will also be Pepsi. The present market share of the Coke and Pepsi is 55% and 45% respectively. Construct the transition probability matrix and draw transition diagram. In the long run, what will be the market share of such cola.

[CO4][6Marks]

Q.5(a) Given the frequency function

$$f(x, \theta) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}(x-\theta)^2/\sigma^2}$$

find the maximum likelihood estimator of θ based on a sample of size n .

[CO5][6Marks]

(b) Given the probability density function

$$f(x, \theta) = [\pi\{1 + (x - \theta)^2\}]^{-1}, \quad -\infty < x < \infty, \quad -\infty < \theta < \infty.$$

Show that the Cramer-Rao lower bound of variance of an unbiased estimator of θ is $\frac{2}{n}$, where n be the size of the random sample.

[CO5][6Marks]



INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, NAGPUR

भारतीय सूचना प्रौद्योगिकी संस्थान, नागपुर

Department of Computer Science and Engineering

CSL 214: Data Handling & Visualization

END SEMESTER EXAM

Semester -III

Duration: 3 Hours

Max Marks: 50 M

Date: 25/11/2023 (Saturday)

Time: 9:00 to 12:00 PM

Important Instructions:

1. All the questions are compulsory.
2. Assume suitable data wherever necessary

Q1(a) Answer the following question>Show the output: CO2

A list.insert(2, 5) inserts element _____ at index _____ 1M
in the list.

B a, b = 0, 1
limit = 100
while a < limit:
 if a < 50:
 print(a, end=' ')
 a, b = b, a + b
2M

C start, end = 10, 50
for num in range(start, end + 1):
 if num > 1:
 for i in range(2, int(num**0.5) + 1):
 if num % i == 0:
 break
 else:
 print(num)
2M

D import numpy as np
matrix = np.array([[1, 2, 3], [4, 5, 6], [7, 8, 9]])
M1 = matrix[:, 1]
M2 = np.diag(matrix)
M3 = matrix[:-1, :]
M4= matrix[-1:5]
print(M1) print(M2) print(M3) print(M4)
2M

E import pandas as pd
data = {'Category': ['A', 'B', 'A', 'B', 'A'],
 'Value': [10, 15, 20, 25, 30]}

df = pd.DataFrame(data)
df2 = df.groupby('Category').sum()
print(df2)
1M

Q1(b) With respect to web data using requests and Beautiful Soup answer the following questions: 3M
CO5

- Write a python code to check the response of particular website either it is 403 or 200.
- Write python code to parse the content into html.
- It html having header <h3> which contains all the president name of India. Write python code to display all the names.

Q2(a) Let us consider the data frame, "df" having the information/data presented in the following table having five columns (a, b, c, d, and e) and 10 rows (0 to 9). Here, some entries in the table are missing and represented as "NaN". 3M
CO2

| | a | b | c | d | e |
|---|----------|-----------|-------|-----|---|
| 0 | 0.093748 | London | True | 3.0 | 1 |
| 1 | 0.835929 | Paris | True | 4.0 | 4 |
| 2 | 0.166490 | New York | True | 5.0 | 5 |
| 3 | 0.439057 | Istanbul | False | 1.0 | 3 |
| 4 | 0.077856 | Liverpool | False | 5.0 | 3 |
| 5 | 0.669849 | Berlin | NaN | 2.0 | 3 |
| 6 | 0.539958 | NaN | NaN | 2.0 | 3 |
| 7 | 0.323087 | Madrid | False | NaN | 8 |
| 8 | 0.367877 | Rome | True | NaN | 8 |
| 9 | 0.281026 | NaN | True | 0.0 | 4 |

With reference to given data-frame 'df' Write the output displayed by the following commands:

- df.iloc[1]
- df.iloc[0, 1]
- df.iloc[:, 2]
- df.iloc[:, 2, 1]
- df.iloc[:, 2, 'b']
- df.iloc[:, 2, : 'b']

Q2(b) The time taken (in seconds) by 50 students to solve a problem was: 5M
CO3

17, 20, 24, 26, 27, 45, 48, 44, 54, 40, 35, 47, 41, 17, 50, 30, 38, 34, 40, 35, 47, 41, 17, 20, 60, 58, 58, 63, 55, 24, 26, 27, 44, 49, 45, 48, 44, 54, 50, 60, 58, 58, 63, 55, 20, 35, 47, 41, 17, 20.

- By taking a class interval 0-10, 11-20, Prepare a frequency distribution and cumulative frequency distribution table for the above data set.
- Which class interval has the minimum and maximum frequency?
- What is the cumulative frequency of the class interval 31 – 40?
- Draw a histogram from the frequency distribution table.
- Classify and describe the histogram based on the frequency distribution of the data. (Which type of histogram is this?)

Q3(a) Write python program to display the following plots: Line plot, Bar plot, and Scatter plot for X = [5, 2, 9, 4, 7] and Y = [10, 5, 8, 4, 2] with proper title, x-label and y-label. Also Draw these plots (Line plot, Bar plot, and Scatter plot) for the given X and Y. 6M
CO1

Q3(b) You have given the following data set:

6M

Example dataset

CO4

```
data = {'Student': ['A', 'B', 'C', 'D', 'E', 'F', 'G', 'H', 'I', 'J', 'K'],  
       'Score': [85, 88, 90, 92, 89, 78, 91, 87, 110, 88, 8]}
```

1. Calculate the Z-Score using the Z-score method.
2. Now set threshold = +- (1) and find the outliers.
3. Now set threshold = +- (2) and find the outliers.
4. Now apply the Interquartile Range (IQR) method to detect the outliers by setting threshold = 2
5. Compare the results of 2, 3, and 4.

Q4(a) Consider the following dataset stored in the googleplaystore.csv having 10472 entries.

5M

CO2

| Column Name | Values |
|----------------------------|---|
| App | Life Made WI-Fi Touchscreen Photo Frame |
| Category | 1.9 |
| Rating | 19.000000 |
| Reviews | 3.0M |
| Size | 21516.529524 |
| Installs | Free |
| Type | 0 |
| Price | Everyone |
| Content Rating | NaN |
| Genres | February 11, 2018 |
| Last Updated | 1.0.19 |
| Current Ver | 4.0 and up |
| Android Ver | NaN |
| Name: 10472, dtype: object | |

1. Write python code to read a CSV file into a pandas DataFrame and display the datatypes of all the columns of the dataframe also show first 3 and last 3 rows.
2. Check the number of null/Nan/Missing values in the columns and Drop the rows having null values in the 'Rating' field
3. Write python code to display the most common value in the Android version column.
4. Write python code to count the apps having price between 0- 30
5. Write a python code to display the data based on the highest rating first.

Q4(b) Suppose you need to complete the project on "Retail Analytics Dashboard for Sales Optimization" 5M
CO5

You have to create an end-to-end retail analytics dashboard using Power BI/Tableau to provide a comprehensive view of sales performance, inventory management, and customer behavior for a multi-location retail chain.

Describe the Key Components and Features of Power BI/Tableau that you will have to display in your dashboard so that the company is able to achieve:

- (a) Improved decision-making through actionable insights into sales trends, customer preferences, and inventory management.
- (b) Increased sales and profitability through targeted marketing efforts and dynamic pricing strategies.
- (c) Enhanced operational efficiency by optimizing inventory levels and supply chain processes.

Q5(a) An e-commerce company was facing declining customer satisfaction ratings, leading to increased customer churn. The management believed that understanding customer feedback and behaviour through effective data handling and visualization could be key to improving overall satisfaction. 3M
CO5

As a Data Analyst what approaches you have to follow to contribute to a positive turnaround in customer satisfaction and business outcomes.

Q5(b) In the 'Nagpur' city of Maharashtra State, the local government has implemented a cutting-edge Smart City Traffic Management System to reduce traffic congestion, enhance public safety, and improve overall transportation efficiency. The system collects and analyses vast amounts of data from various sources to make real-time decisions and provide valuable insights for long-term planning. 6M
CO5

In this scenario describe the following:

- (i) Data Collection Process
- (ii) Data Handling Process
- (iii) Data Visualization Process



Date: 23/11/2023

End Semester Examination
Duration: 3 hours

Semester – III

Max. Marks: 60

Important Instructions:

- All questions are compulsory.
- Questions carry marks as indicated.
- No assumptions are to be made in the answers.

| | | | |
|------|---|------------------------------|------------|
| Q1.A | Create a brand awareness of Nike using Gamification. You must include 6 different ways of brand awareness. | (6M) | CO1 CO3 |
| Q1.B | What are the different types of game players? | (3M) | CO1 |
| Q1.C | How does the MDA framework contribute to the success of the game Minecraft? | (3M) | CO2 |
| Q2.A | What are all of the game dynamics that contribute to the engaging and thrilling gameplay experience in Asphalt 9: Legends? | (6M) | CO2 CO1 |
| Q2.B | Which game mechanics could be used for any activity for the theme: ‘prosperity of the nation’? | (6M) | CO2 CO3 |
| Q3.A | How effectiveness of gamification is measured? | (4M) | CO1 |
| Q3.B | State <u>key</u> difference between: i. game-based and gamified assessments ii. story, exaggerated story, and storytelling | (2x2M) =4M | CO1 |
| Q3.C | "Conflict: Desert Storm" is a tactical third-person shooter video game set during the Gulf War. It allows players to control a squad of special forces soldiers in various missions behind enemy lines, engaging in intense combat against Iraqi forces. For the above game, discuss the following: i. Categorization of the game into gameplay, simulations, and game ii. Intrinsic and extrinsic motivation iii. Terminal and enabling learning objectives iv. Elements of game mechanics | (1M) (1M) (2M) (2M) | CO2 CO3 |
| Q4.A | Why do employers use game-based assessments for the hiring process? | (4M) | CO3 |
| Q4.B | For the game Minecraft, what part of the game will come under legal issues such as privacy, copyright, trademarks and ownership? Justify. | (4M) | CO3 |
| Q5.A | Analyze a popular fighting game - TEKKEN 7 using the Octalysis framework in detail. | (8M) | CO2 |

Q5.B State the accurate/exact ILE for the following learning outcomes. (0.75x8 CO1)

- i. Encourage learners to independently build skills or acquire knowledge =6M
- ii. Provide a safe and realistic environment for learners to practice skills and to make mistakes
- iii. Test learners' knowledge of facts, concepts, and terms
- iv. Teach learners how to carry out or use a procedure by executing or implementing
- v. Teach learners how to retrieve, recognize, and recall relevant knowledge from long-term memory
- vi. Encourage learners to return to a curriculum on a regular basis
- vii. Build lead leadership skills
- viii. Realistically prepare learners for a future state



Date: 11/2024

End Semester Re-Examination
Duration: 3 hours

Semester – III

Max. Marks: 60

Important Instructions:

- All questions are compulsory.
- Questions carry marks as indicated.
- No assumptions are to be made in the answers.

- Q1. Todoist is a to-do list management workspace which inspires individuals to complete everyday tasks and cross everything off their to-do lists. Todoist want to implement gamification. Justify following questions as why gamification must be implemented with Todoist (8M) CO1 CO3
- a. Why are you gamifying this project?
 - b. What are your objectives?
 - c. What are your target behaviors?
 - d. How will gamification help you achieve your objectives?
- Q2. Use Herger checklist to evaluate gamification tool-Duolingo. (10M) CO2
- Q3 "Storytelling is more art than science". Justify the statement with example of Mario game. Also discuss the elements of game storytelling. (10M) CO2
- Q4 How and which game elements can be effective from a learning or motivational perspective in the game. (10M) CO2 CO1
- Q5 For the game counter strike, discuss the following: (3M*4 = 12M) CO2 CO3
- i. Categorization of the game into gameplay, simulations, and game
 - ii. Intrinsic and extrinsic motivation
 - iii. Terminal and enabling learning objectives
 - iv. Elements of game mechanics
- Q6 "The player will always assume the game is much more complex than it actually is." (10M) CO2 CO3

For the above statement, how storytelling and feedbacks of simulations plays a key role.



Important Instructions:

- All the questions are compulsory. Write all the subparts of each question together.
- Maximum marks that can be obtained for a particular question are indicated in the brackets [] on the extreme right of the corresponding question

Q1-a. Consider a 1MBPS IO device interfaced to a CPU in a cycle stealing mode of DMA. Whenever 64 Byte data is available in the buffer then it is transferred into memory. Machine cycle time is 5μ sec.

- i.What is the % of time the processor is blocked due to DMA ?
- ii.If the machine cycle time is 4μ sec then calculate the % of time the CPU is in a busy state.

Q1-b. Suppose SDRAM cells are arranged in 8k rows, takes 4 cycles to access(read) each row , has a clock rate of 133MHz and refresh time of typical SDRAM is 64ms , then

- i.Calculate time needed to refresh all rows.
- ii.What is refreshing overhead of accessing the memory in the above SDRAM.

[6+4=10M , (CO-4, CO-5)]

Q2-a. Consider the hex value 0x20030007 as representing one MIPS machine language instruction.

- i.Convert the hex value to a 32-bit binary value.
- ii.What is the opcode value for this instruction (in decimal)?
- iii.What is the name of that instruction with that opcode?
- iv.What is the format(R,I, or J) of the instruction?

[2+1+1+1=5M,CO-3]

Q2-b. Let's take a recursive procedure , showing nested procedure linking

```
int fact(int n)
{
    if (n<1) return (1);
    else return (n*fact(n-1));
}
```

What is MIPS assembly code for the above C code ?

[5M, CO-3]]

Q3-a. Suppose you wish to run a program P with 7.5×10^9 instructions on a 5 GHz machine with a CPI of 0.8

- i.What is the expected CPU time of program P.
- ii.When you run P, it takes 3 seconds of wall clock time to complete.What is the percentage of CPU time program P received?

[1+1= 2M,CO-1]

Q3-b. i.Draw the complete single cycle datapath for R-type instructions of mips instructions and also mention the control signals involved in it.

- ii.Design a 4 stage pipeline and discuss how to improve the performance of a pipeline.

[4+4 = 8M , CO-4]

Q4-a. A cache memory has a hit rate of 0.7 has an access latency 12 ns and miss penalty 95 ns .Optimisation is done on the cache to reduce the miss rate. However , the optimisation results in an increase of cache access latency to 15 ns , whereas the miss penalty is not affected . Find the minimum hit rate (rounded off to two decimal places) needed after optimization such that it should not increase the average memory access time.

Q4-b. Consider a fully associative cache memory with 4 lines that implements Most Recently Used (MRU) cache replacement algorithm for the following block requests

1,4,2,3,5,6,1,2,3,4,5,4,5,1,2,3,4

- i.What is miss ratio and hit ratio respectively.
- ii.Calculate the hit ratio using Belady's optimal algorithm for the above requests and compare both cache replacement algorithm

Q4-c. Briefly demonstrate the techniques to avoid cache coherence problem.And also derive the expression for average read cycle time and average write cycle time (time required to read or write one word data from the memory .

[3+4+3 = 10M, CO-3]

Q5-a. Draw the flowchart for Booth Algorithm in arithmetic multiplication and multiply (-10) and (-4).

Q5-b. An instruction is stored at location 1300 with its address field at location 1301. The address field has the value 400.A processor register R1 contains the number 200.Evaluate the effective address if the addressing mode of the instruction is

- i.Direct
- ii..Immediate
- iii.Relative
- iv.Register indirect
- v.Index with R1 as the index register

[5+5 = 10M, CO-2, CO-3]



INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, NAGPUR

Department of Computer Science and Engineering

CSL 212: Computer Architecture and Organization

END SEMESTER RE-EXAM

Semester -III

Date: 02/01/2024 (Tuesday)

Time: 8:00 AM to 11:00 AM

Duration: 3 Hours

Max. Marks: 50M

Important Instructions:

- All the questions are compulsory. Write all the subparts of each question together.
- Maximum marks that can be obtained for a particular question are indicated in the brackets [] on the extreme right of the corresponding question.

Q1-a. Consider a direct mapped cache with block size 4kB. The size of main memory is 16 GB and there are 10 bits in tag.

- Calculate size of cache memory.
- What is the size of tag directory.

[3+2 = 5 M, (CO-4)]

Q1-b. Differentiate Static Random Access memory and Dynamic Random Access memory with appropriate diagrams.

[6 M, (CO-4)]

Q2-a. An instruction is stored at location 1100 with its address field at location 1101. The address field has the value 500. A processor register R1 contains the number 100. Evaluate the effective address if the addressing mode of the instruction is

- Direct
- Immediate
- Relative
- Register indirect

[4 M, (CO-1)]

Q2-b. i. Differentiate Byte addressable and Word addressable memory.

ii. Suppose a 32 bit hypothetical processor which supports 128MB memory. Then the system is enhanced with a word addressable memory. Then how many address pins are saved in the enhanced CPU.

[2+3=5 M, CO-4]

Q3-a. Explain little endian and big endian nesting techniques with suitable examples.**Q3-b.** Write down the principles of designing a processor.**Q3-c.** How performance is related to clock cycle time? If the execution time of computer A is 9 sec and computer B is 12 seconds, then calculate the performance ratio of computer A to computer B.

[3+2+5=10 M, CO-1, CO-5]

Q4-a. What is cache coherence? Analyze the writing strategies of the cache memory.

[5 M, CO-4]

Q4-b. Draw the complete single cycle datapath for L-type instructions of mips instructions and also mention the control signals involved in it.

[5 M, CO-3]

Q5-a Multiply (-10) and (-4) using Booth's algorithm.

[5 M, CO-4]

Q5-b Write the IEEE 754 single precision format of the number 85.125. Also convert it into hexadecimal format.

[5 M, CO-2]
