

Registration No :

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Total Number of Pages : 02

Course: MCA  
Sub\_Code: MCA01001

1<sup>st</sup> Semester Regular/Back Examination: 2022-23

SUBJECT: Discrete Mathematics

BRANCH(S): MCA (2 Years)

Time : 3 Hour

Max Marks : 100

Q.Code : L586

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions :

(2 x 10)

- Show that the conditional statement  $(p \wedge q) \rightarrow (p \rightarrow q)$  is a tautology.
- Find the five term of the sequence defined by the recurrence relation  $a_n = a_{n-1}^2, a_1 = 2$ .
- Let  $n$  and  $r$  be nonnegative integers with  $r \leq n$ . The show that  $C(n, r) = C(n, n-r)$ .
- How many relations are there on the sets with 5, 7 and 9 elements.
- Using Warshall's algorithm find the transitive closures of the relation  $\{(a, c), (b, d), (c, a), (d, b), (e, d)\}$ .
- Prove that any tree with at least two vertices has more than one vertex of degree one.
- Prove or disprove that matrix multiplications are commutative.
- Show that every subgroup of an abelian group is normal.
- How many different Boolean functions of degree  $n$  are there?
- Determine whether the partial order set  $(P(S), \subseteq)$  is a lattice?

Part-II

Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) (6 x 8)

- How many ways are there for 10 women and 6 men to stand in a line so that no two men stand next to each other.
- Using mathematical induction prove that  $n^3 - n$  is divisible by 3 whenever  $n$  is a positive integer.
- Solve the recurrence relation  $a_n = a_{n-1} + 2a_{n-2}, a_0 = 2, a_1 = 7$ .
- Let  $R$  be the relation on the set of real numbers such that  $aRb$  iff  $a - b$  is an integer. Is  $R$  an equivalence relation? Justify your answer.
- Prove or disprove that there is no connected Eulerian simple graph that has even number of vertices and odd number of edges.

- f) If  $G$  is minimally connected then prove that  $G$  is a tree.
- g) In  $S_3$  show that there are four elements satisfying  $x^2 = e$  and three elements satisfying  $y^3 = e$ .
- h) Show that every cyclic group is commutative.
- i) Let  $f: G \rightarrow G'$  be a homomorphism. Prove that  $\text{Ker } f$  is a normal subgroup of  $G$ .
- j) Find the dual of the Boolean expressions: (i)  $\bar{x}\bar{y}$  (ii)  $xyz + \bar{x}\bar{y}\bar{z}$ .
- k) What is lattice? Let  $X = \{2, 3, 6, 12, 24, 36\}$  relation such that  $X$  divides  $Y$ . Draw the hasse diagram.
- l) Find the dual of the Boolean expressions: (i)  $\bar{x}\bar{y}$  (ii)  $xyz + \bar{x}\bar{y}\bar{z}$ .

### Part-III

#### Only Long Answer Type Questions (Answer Any Two out of Four)

- Q3** a) Solve the following recurrence relation using generating function (16)  
 $a_n - 2a_{n-1} - 15a_{n-2} = 0$  for  $n \geq 2$  and  $a_0 = 0, a_1 = 1$ .
- b) Define generalized Pigeon-hole principle. Students are awarded 4 grades A, B, C, and D. How many students must be there in a group so that at least 6 students get the same grade?
- Q4** a) Using Kuratowski's theorem, determine whether the Peterson's graph is planar or not. (16)
- b) How many reflexive relations are there on a set with  $n$  elements? Define transitive relations with an example.
- Q5** Define integral domain. Show that every field is an integral domain but converse is not true. When an integral domain becomes a field? Explain the answer in details. (16)
- Q6** Define Boolean algebra. Show that the power set  $P(S)$ , of a set  $S$  is a Boolean algebra under the set operations, where 0 and 1 are respectively the null set and universal set. (16)

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Total Number of Pages : 03

Course: MCA  
Sub\_Code: MCA01002

1<sup>st</sup> Semester Regular/Back Examination: 2022-23

SUBJECT : Computer System Architecture

BRANCH(S): MCA

Time : 3 Hour

Max Marks : 100

Q.Code : L598

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions:

(2 x 10)

- a) State and explain Amdahl's law.
- b) The memory access time is 1 nanosecond for a read operation with a hit in cache, 5 nanoseconds for a read operation with a miss in cache, 2 nanoseconds for a write operation with a hit in cache and 10 nanoseconds for a write operation with a miss in cache. Execution of a sequence of instructions involves 100 instruction fetch operations, 60 memory operand read operations and 40 memory operand write operations. The cache hit-ratio is 0.9. Compute the average memory access time (in nanoseconds) in executing the above sequence of instructions.
- c) Write the procedure of optimal page replacement with a suitable example.
- d) Define arithmetic pipelining.
- e) What do you mean by Cache coherence?
- f) The content of the top of a memory stack is 5320. The content of the stack pointer SP is 3560. A two-word call subroutine instruction is in memory at address 1120 followed by the address field of 6720 at location 1121. What is the content of PC, SP, and the top of the stack?
- g) Give an example of data hazard in a pipeline architecture.
- h) A four-stage pipeline has stage delays as 150, 120, 160 and 140 ns respectively. Registers are used between the stages and have a delay of 5 ns each. Assuming constant clocking rate, calculate the total time taken to process 1000 data items on this pipeline.
- i) Distinguish between Superpipelined and Superscalar processor.
- j) Differentiate between Microprogramming and Hardwired control unit

**Part-II**

**Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) (6 × 8)**

- a) Design the control unit of a basic computer. A computer has 16 registers an ALU with 32 operations and a Shifter with eight operations all connected to common Bus system.
  - (a) Formulate a control word for a microoperation.
  - (b) Specify the number of bits in each field of control word and give an encoding scheme
- b) A computer uses chips of 1024x1capacity.
  - (a) How many chips are needed and how should their address lines be connected to provide a memory capacity of 1024 bytes.
  - (b) How many chips are needed to provide a memory capacity of 16 K bytes? Explain in words how the chips are to be connected to address bus.
- c) Consider the following instruction sequence where register R1, R2 and R3 are general purpose and MEMORY[X] denotes the content at the memory location X.

Instruction	Semantics	Instruction Size (bytes)
MOV R1, (5000)	$R1 \leftarrow \text{MEMORY}[5000]$	4
MOV R2, (R3)	$R2 \leftarrow \text{MEMORY}[R3]$	4
ADD R2, R1	$R2 \leftarrow R1 + R2$	2
MOV (R3), R2	$\text{MEMORY}[R3] \leftarrow R2$	4
INC R3	$R3 \leftarrow R3 + 1$	2
DEC R1	$R1 \leftarrow R1 - 1$	2
BNZ 1004	Branch if not zero to the given absolute address	2
HALT	Stop	1

Assume that the content of the memory location 5000 is 10, and the content of the register R3 is 3000. The content of each of the memory locations from 3000 to 3010 is 50. The instruction sequence starts from the memory location 1000. All the numbers are in decimal format. Assume that the memory is byte addressable. Find the content of memory location 3010 after the execution of the program.

- d) Assume a cache miss penalty is 100 clock cycles, and all instructions take 1.0 clock cycles. Let the average miss rate is 2%, there is an average of 1.5 memory references per instructions, and the average number of cache misses per 1000 instructions is 30. What is the impact on the performance and calculate the impact using both misses per instruction and miss rate?
- e) What is virtual memory? How is a logical address mapped to physical address in virtual concept? Explain with example and diagram.

- f) What is a Pipeline Hazard? How is control hazard detected and resolved? Explain with example.
- g) Define demand paging? Explain the various page replacement techniques.
- h) What are the criteria on which memory hierarchy is formed? What information it conveys? Differentiate between main memory and cache memory
- i) What is the basic working principle of VLIW processor? What are the advantages of a VLIW processor?
- j) Compare the features of Array Processor and Vector Processors.
- k) Explain memory consistency issue in shared memory architecture.
- l) Write short notes on cluster computing.

### Part-III

#### Only Long Answer Type Questions (Answer Any Two out of Four)

- Q3** Define the term pipelining? Distinguish between Instruction pipeline and Arithmetic Pipeline. Explain different types of hazards that occur in instruction pipeline and how to handle them. **(16)**
- Q4** Explain the role of cache in memory hierarchy. Explain direct, associative, and set-associative cache mapping techniques with suitable examples. C A block-set associative cache consists of a total of 64 blocks divided into 4 blocks sets. The main memory contains 4096 bocks, each consisting of 128 words.  
 i) How many bits are there in the main memory address?  
 ii) How many bits are there in each of the TAG, SET and WORD fields? **(16)**
- Q5** Discuss the basic concepts for increasing Instruction-level Parallelism. A superscalar processor has 5 issue slots which can be filled up in a single clock cycle. During execution of a certain application consisting of 1000 instructions the following are observed:  
 10% of the instructions were issued by filling up exactly 1 issue slot only, 20% of the instructions were issued by filling up exactly 2 issue slots only, 20% of the instructions were issued by filling up exactly 3 issue slots only, 48% of the instructions were issued by filling up exactly 4 issue slots only, and the remaining instructions were issued by filling up all the slots. But due to some reason it was found that a total of 500 clock cycles were consumed while issuing all these 1000 instructions. Find out the speedup factor in issuing instructions when there is zero vertical waste as compared to with vertical waste in the above-mentioned scenario. **(16)**
- Q6** Write the taxonomy of parallel architectures with neat diagram. Compare and contrast centralized shared- memory architecture and distributed shared memory architecture. **(16)**

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Total Number of Pages : 02

Course: MCA  
Sub\_Code: MCA01003

1<sup>st</sup> Semester Regular/Back Examination: 2022-23

SUBJECT : C and Data Structure

BRANCH(S): MCA (2 Yrs)

Time : 3 Hour

Max Marks : 100

Q.Code : L614

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

**Part-I**

**Q1 Answer the following questions:**

**(2 x 10)**

- Convert  $(FEE)_{16}$  to decimal form, followed by octal form.
- What is the ternary operator? Write its syntax and the actual code that it means.
- Define data type. Explain primitive data types supported by C language.
- Given base address 4000, what is the address of element  $A[5]$  in an integer array  $A[]$ ? Assume that memory is byte addressable and the size of integer is 4 byte.
- Write any three library functions to read from a file. If `fopen()` functions is not able to open a file, what does it returns?
- Suppose a circular queue of capacity  $n$  elements is implemented with an array of  $n$  elements. Assume that the insertion and deletion operation are carried out using `REAR` and `FRONT` as array index variables, respectively. Initially, `REAR = FRONT = -1`. Write the conditions to detect queue full and queue empty.
- Explain the meaning of the following declaration.  
`int *fun (char *, int *);`
- What is the difference between call by value and call by reference?
- What is the significance of dynamic memory allocation? Differentiate the syntactical difference between `malloc()` and `calloc()`.
- Evaluate the postfix expression  $< 7, 6, 3, 4, +, 9, *, +, 4, +, * >$

**Part-II**

**Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) (6 x 8)**

- Define constant. List the different types of C constants.
- An electricity board charges the following rates for the use of electricity: for the first 150 units Rs 1 per unit; for the next 100 units Rs 2 per unit; beyond 250 units Rs 3 per unit. All users are charged a minimum of Rs. 75 as meter charge. If the total amount is more than Rs 300, then an additional surcharge of 12.5% of the total amount is charged. Write a program to read the number of units consumed and print out the charges. Use single-line comments to denote the charge ranges.
- Distinguish between entry-controlled loop and exit-controlled loop. Write a program to find the sum of all prime numbers from 1 to  $n$  (taking  $n$  as user input).
- What is recursion in C functions? Define a recursive function that takes input as number of terms ' $n$ ' and returns the  $n^{\text{th}}$  Fibonacci term.

- e) Write a program to print the values of  $\sin(x)$  in the interval 0 to 180 degrees in steps of 15 degrees.  $x$  is in degree. Do not use any library functions. The accuracy of  $\sin(x)$  must not be less than 0.00001.
- f) Write the syntax of different branching statements and explain their working with examples. Write a C program to print all the leap years between 1 to 2000.
- g) Write a C program to multiply two matrices of dimension  $n \times n$  and store the result in another matrix.
- h) Write a program in C to reverse a string by using pointer.
- i) Write a program in C to read a text file named input.txt consisting of meaningful sentences (at least 1000 words). Count total number of words and display the most frequently occurred word along with its count.
- j) How do you push and pop elements in a stack. Show the content of an initially empty stack after performing each of the following operations: push(10), push(20), push(30), pop, push(40), pop, pop, push(30)
- k) Why do we use asymptotic notations in the study of algorithms? Describe commonly used asymptotic notation and give their significance.
- l) What are the queues? Write down algorithm for inserting and deleting elements from a circular queue implemented using arrays.

### Part-III

#### Only Long Answer Type Questions (Answer Any Two out of Four)

- Q3** Explain the syntax of user defined functions with a suitable example. Explain the different types of functions based on parameters. Write a C function to arrange the elements of an input array in ascending order. **(16)**
- Q4** Discuss the various operators used in C programming with suitable examples. Illustrate the declaration and initialization of one-dimensional and two-dimensional array. Write a C program to calculate the sum of top 3 elements of an input two-dimensional array. **(16)**
- Q5** What is a structure? Explain the components of a structure. Distinguish between structure and union with suitable examples. **(16)**  
 Define a structure called cricket that will describe the following information:
  - player name
  - team name
  - batting average
 Using cricket, declare an array player with 50 elements and write a program to read the information about all the 50 players and print a team-wise list containing names of players with their batting average.
- Q6** What is postfix notation? Explain with an example. Write the algorithm for converting from infix to postfix. Show the detailed steps to convert given infix to postfix:  
 $p + q * r + (s * t + u) * v$  **(16)**

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Total Number of Pages : 03

Course: MCA  
Sub\_Code: MCA01004

1<sup>st</sup> Semester Regular/Back Examination: 2022-23

SUBJECT: Operating System

BRANCH(S): MCA (2 Yrs)

Time : 3 Hour

Max Marks : 100

Q.Code : L625

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions :

(2 x 10)

- What do you mean by spooling? Give one example.
- Differentiate between hard real time and soft real time operating system.
- What is problem of priority scheduling? Write down its solution.
- Write the difference between light weight process and heavy weight process.
- At a particular time of computation, the value of a counting semaphore is 7, then 20 P-operation and 15 V-operation were completed on the semaphore. What is the resulting value of semaphore?
- What is spinlock? Write down its advantages.
- What is Belady anomaly? Why it occurs?
- Let an instruction takes  $i$  ms and page fault takes additional  $j$  ms. If the average page fault after  $k$  instruction what is the average instruction time.
- If page size is 4KB and logical addresses 22 bits, what is the number of entries in page table?
- Differentiate between direct access and sequential access of file accessing method.

Part-II

Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)

- Define thread. What are similarities and differences between thread and process?
- Differentiated between deadlock and starvation. State four conditions of deadlock.
- Define process. Explain different states of a process with the help of state diagram.
- What is race condition? What are all the conditions that should hold good for its solution?
- Distinguish between multiprogramming and multiprocessing. What is the key motivation for the development of each one?
- Consider a system with main memory access time of 100ns and TLB access time=20ns TLB hit ratio=95%  
What is effective memory access time with and without TLB?
- Explain the structure of a disk with neat diagram.
- Write the difference between paging and segmentation.
- How does the system detect thrashing? Once it detects thrashing, what can the system do to eliminate this problem?

- j) Explain contiguous linked and index allocation of disk space with its relative advantages and disadvantages.
- k) Given a memory partition of 200k, 500k, 300k and 600k (in order). How would each of first-fit, best-fit, worst-fit algorithms place processes of 212 k, 417 k, 112 k and 426 k (in order)? Which algorithm makes the most efficient use of memory?
- l) Define virtual memory. What are the implementation techniques of Virtual memory

**Part-III**

**Only Long Answer Type Questions (Answer Any Two out of Four)**

- Q3** a) What are the major activities of an operating system? What are the main advantages of layered approach to system design? (8)
- b) Consider the following set of processes, with the arrival times and CPU burst time given in ms (8)

Process	Arrival Time	Burst Time
P1	0	5
P2	1	3
P3	2	3
P4	4	1

What is average turnaround time (average waiting and average response time) for these processes with the Shortest Remaining Processing Time First?

- Q4** a) What is the producer consumer problem? Write down solutions for producer consumer problem? (8)
- b) Consider the following snapshot of a system (8)

P\R	ALLOCATION					MAX					AVAILABLE			
	A	B	C	D		A	B	C	D		A	B	C	D
P <sub>0</sub>	0	0	1	2		0	0	1	2		1	5	2	0
P <sub>1</sub>	1	0	0	0		1	7	5	0					
P <sub>2</sub>	1	3	5	4		2	3	5	6					
P <sub>3</sub>	0	6	3	2		0	6	5	2					
P <sub>4</sub>	0	0	1	4		0	6	5	6					

Answer the following questions using the Banker's algorithm:

- (i) What is the content of matrix Need?

Is the system in a safe state? If yes, what is the safe sequence? Show the detailed steps as per Banker's Algorithm

- Q5 a) Suppose we have a disk with 512 cylinders, and the disk is currently at cylinder 110 (and has previously just processed a request for cylinder 105) and the disk queue contains read/write requests for sectors on cylinders 84, 302, 103, 96, 407 and 113. (Cylinders start at number 1). How far must the read travel to satisfy the requests in the queue using FCFS, SCAN, CSCAN and SSTF? (8)
- b) A process has been allocated 3 pages frames. Assume that none of pages of the process are available in the memory initially. The process makes the following sequence page reference (8)

1	2	1	3	7	4	5	6	3	1
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What is number of page fault occurs in FIFO, LRU and Optimal Page replacement algorithm?

- Q6 a) Define RAID. Explain different level of RAID with its relative advantages and Disadvantages. (8)
- b) Consider a Unix system (8)
- 10 direct block pointer
  - One single indirect Pointer
  - One double indirect pointer
  - Block Size = 8KB
  - Disk Size = 8KB
  - Block Pointer Size = 8B
- What is the Maximum file size?

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Total Number of Pages : 02

Course: MCA  
Sub\_Code: MCA01005

1<sup>st</sup> Semester Regular/Back Examination: 2022-23

SUBJECT : Database Engineering

BRANCH(S): MCA (2 Yrs)

Time : 3 Hour

Max Marks : 100

Q.Code : L644

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

**Part-I**

**Q1 Answer the following questions : (2 x 10)**

- a) In Relational model what do you mean by cardinality?
- b) Explain the following constraints: Primary Key and Foreign key with an example of each
- c) How can you map a conceptual model to a relational model?
- d) Differentiate between the following: Theta Join, Equi Join, Natural Join and Outer Join.
- e) A primary key if combined with a foreign key creates what?
- f) Differentiate between:
  - a) Procedural and non procedural DML
  - b) Catalog and meta data
- g) What is ACID property?
- h) A primary key if combined with a foreign key creates what?
- i) What is the possible violation if an application program use isolation level "Repeatable Read"
- j) Define the properties of a transaction and who ensures them?

**Part-II**

**Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) (6 x 8)**

- a) What do you understand by a data model? Explain the difference between conceptual data model and the internal model.
- b) What are the basic operations for a relational language? How are basic operations represented in relational algebra and SQL?
- c) What is the use of DML in DBMS?
- d) Which protocol always ensures recoverable schedule?
- e) Does a relation in a 3<sup>rd</sup> Normal form satisfy the properties of Lossless decomposition and dependency preservation? Explain with an example
- f) Given R with FD set  $F = \{A \rightarrow B, BC \rightarrow D, D \rightarrow BC, DE \rightarrow \emptyset\}$  Find the number of redundant FDs in F.
- g) Given R(ABCDEFGH) with FDs  $F = \{A \rightarrow C, B \rightarrow D, E \rightarrow F, G \rightarrow H, C \rightarrow G\}$ . How many number of candidate keys are there? Which normal form R is in ?
- h) Why do query optimizers consider only left-deep join trees? Give an example of a query and a plan that would not be considered because of this restriction.
- i) What is normalization? Explain the first and second normal forms using appropriate example.

- j) What is the possible violation if an application program use isolation level "Repeatable Read"
- k) Explain the entity integrity and referential integrity constraints. How they are use full in database Design?
- l) Explain with the help of examples, the concept of insertion anomalies and deletion anomalies

**Part-III**

**Only Long Answer Type Questions (Answer Any Two out of Four)**

- Q3** a. Describe the various database recovery techniques in brief. **(8x2)**
- b. Consider the relations:  
     PROJECT(proj#, proj\_name, chief\_architect)  
     EMPLOYEE(emp#, emp\_name)  
     ASSIGNED(proj#, emp#)  
     Use relational algebra to express the following queries:  
 (a) Get details of employees working on project COMP33.  
 (b) Get the employee number of employees who work on all projects.  
 (c) Get details of project on which employee with name 'RAM' is working.
- Q4** a. Explain various locking technique for concurrency control. **(8x2)**
- b. How multiversion timestamp ordering and multiversion two-phase concurrency control schemes execute concurrent transactions in controlled manner?
- Q5** a. Discuss the correspondence between the E-R model construct and the relational model construct. Show how each E-R model construct can be mapped to the relational model using suitable examples? **(8x2)**
- b. Define a view in SQL. Construct a view for the above relations which has the the S#, SNAME, P#, PNAME renamed as SNO, NAME, PNO, PNAME.
- Q6** a. Suppose that we decompose the schema  $R = (A, B, C, D, E)$  into  $R_1 = (A, B, C)$  and  $R_2 = (A, D, E)$ . Show that this decomposition is lossless-join and not dependency-preserving if the following set of functional dependencies F holds: **(8x2)**
- $A \rightarrow BC$   
 $CD \rightarrow E$   
 $B \rightarrow D$   
 $E \rightarrow A$
- b. Consider the following relations:  
 S (S#, SNAME, STATUS, CITY)  
 SP (S#, P#, QTY)  
 P (P#, PNAME, COLOR, WEIGHT, CITY)  
 Give an expression in SQL for each of queries below:  
 (a) Get supplier names for supplier who supply at least one red part  
 (b) Get supplier names for supplier who do not supply part P2.

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Total Number of Pages: 02

Course: MCA  
Sub\_Code: MCA01001

1<sup>st</sup> Semester Regular/Back Examination: 2023-24

SUBJECT: Discrete Mathematics

BRANCH(S): MCA (2 Years)

Time: 3 Hour

Max Marks: 100

Q.Code: N476

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions:

(2 x 10)

- Find the generating functions for  $(1+x)^{-n}$  and  $(1-x)^{-n}$ , where  $n$  is a positive integer, using the extended binomial theorem.
- How many ways are there to assign five (5) different jobs to four (4) different employees if the employee is assigned at least one job?
- Find the value of  $C(5,3)$ .
- Define reflexive, symmetric, and transitive properties.
- Explain Graph isomorphism with a suitable example.
- Define Chromatic number. Find the chromatic number of  $K_n$ .
- What is the order of permutation  $\begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 7 & 6 & 1 & 2 & 3 & 4 & 5 \end{bmatrix}$ ?
- State Lagrange's theorem.
- Define Boolean algebra.
- State the principle of inclusion-exclusion.

Part-II

Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)

(6 x 8)

- Use generating functions to find the number of  $r$ -combinations from a set with  $n$  elements when repetition of elements is allowed.
- For all nonnegative integers  $n$ , show that  $1 + 2 + 2^2 + \dots + 2^n = 2^{n+1} - 1$ .
- Find a recurrence relation for the number permutations of a set with  $n$  elements.
- If  $G$  is minimally connected then prove that  $G$  is a tree.
- Let  $\Phi$  be a homomorphism from a group  $G$  to a group  $\bar{G}$ . Then show that  $\ker \Phi$  is a normal subgroup of  $G$ .
- Find all the distinct left cosets of  $H = 5\mathbb{Z}$  in the group  $(\mathbb{Z}, +)$ .
- Prove that every permutation of a finite set can be written as a cycle or as a product of disjoint sets.

- h) What is lattice? Let  $X = \{2, 3, 6, 12, 24, 36\}$  relation such that  $X$  divides  $Y$ . Draw the hasse diagram.
- i) Show that  $(P(S), \subseteq)$  is a lattice, where  $S$  is a set.
- j) Discuss about various error correction codes.
- k) Explain any one method for error correction.
- l) Write a short note on Coding Theory.

### Part-III

#### Only Long Answer Type Questions (Answer Any Two out of Four)

- Q3** Define generalized Pigeon-hole principle. Students are awarded 5 grades A, B, C, D, and E. How many students must be there in a group so that at least 6 students get the same grade? (16)
- Q4** Define chromatic number and vertex colouring. Prove that every planar graph is 6-vertex colourable. (16)
- Q5** State and prove Lagrange's theorem. Also discuss about the converse of this theorem. (16)
- Q6** Explain Boolean algebra with the help of an example. Again, discuss the uniqueness of finite Boolean expression. (16)

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Total Number of Pages: 02

Course: MCA  
Sub\_Code: MCA01002

1<sup>st</sup> Semester Regular/Back Examination: 2023-24

SUBJECT: Computer System Architecture

BRANCH(S): MCA (2 Yrs)

Time: 3 Hour

Max Marks: 100

Q.Code: N522

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions:

(2 x 10)

- What are the functionalities of program counter, instruction register, and data register?
- What is a parallel computer?
- What do you mean by Cache coherence?
- What are the issue policies for superscalar instructions?
- A four-stage pipeline has stage delays as 150, 120, 160 and 140 ns respectively. Registers are used between the stages and have a delay of 5 ns each. Assuming constant clocking rate, calculate the total time taken to process 1000 data items on this pipeline.
- What do you mean by logical organization of parallel programming platforms?
- Is VLIW a RISC or CISC? Justify.
- What is meant by anti-dependence? How is it removed?
- What are the disadvantages of using symmetric shared memory?
- Given page reference string: 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. Find the number of page faults for optimal page replacement algorithm.

Part-II

Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)

(6 x 8)

- Write the Amdahl's law and its significance.
- Consider a 4-stage pipeline that consists of Instruction Fetch (IF), Instruction Decode (ID), Execute (Ex) and Write Back (WB) stages. The times taken by these stages are 50 ns, 60 ns, 110 ns, and 80 ns respectively. The pipeline registers are required after every pipeline stage, and each of these pipeline register consumes 10ns delay. What is the speedup of the pipeline under ideal conditions compare to the corresponding non-pipelined implementation?
- Distinguish between Instruction pipeline and Arithmetic Pipeline.
- Explain the memory interleaving technique with suitable example.

- e) A computer has an 8 GByte memory with 64-bit word sizes. Each block of memory stores 16 words. The computer has a direct-mapped cache of 128 blocks. The computer uses word level addressing. What is the address format? If we change the cache to a 4- way set associative cache, what is the new address format?
- f) Describe Flynn's classification of computer architecture.
- g) What do you mean by Speed-Up of pipeline? Derive equations of Speed-Up and Efficiency for Pipeline, Super pipeline, and Super scalar architecture.
- h) A block-set associative cache consists of a total of 64 blocks divided into 4 blocks sets. The main memory contains 4096 blocks, each consisting of 128 words.
  - I. How many bits are there in the main memory address?
  - II. How many bits are there in each of the TAG, SET and WORD fields?
- i) Define demand paging? Explain the various page replacement techniques.
- j) Compare the features of Array Processor and Vector Processors.
- k) Explain memory consistency issue in shared memory architecture.
- l) What is cloud computing explain its characteristics and features?

### Part-III

#### Only Long Answer Type Questions (Answer Any Two out of Four)

- Q3 Define the term pipelining. Distinguish between Instruction pipeline and Arithmetic Pipeline. Explain different types of hazards that occur in instruction pipeline and how to handle them. (16)
- Q4 Describe cache memory and mapping policies with suitable examples. Consider a 16-way set-associative cache having 64 bits long Data words. The cache holds 2 Mbytes of data, and each block holds 16 data words. Physical addresses are 64 bits long. How many bits of tag, index, and offset are needed to support references to this cache? (16)
- Q5 Briefly describe the VLIW processor architecture. (16)  
 What are the differences between a superscalar processor and V.L.I.W. processor?  
 Suppose your program consists of 2500 instructions. The proportion of different kinds of instructions in the program is as follows:  
 Data transfer instruction 50%, arithmetic instruction 30%, and branching related instructions 20%. The cycles consumed by these types of instructions are 2, 5, and 10 respectively. What will be the execution time for a 4 GHz processor to execute your program?
- Q6 Write the taxonomy of parallel architectures with neat diagram. Compare and contrast centralized shared-memory architecture and distributed shared memory architecture. (16)

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Total Number of Pages: 03

Course: MCA  
Sub\_Code: MCA01003

1<sup>st</sup> Semester Regular/Back Examination: 2023-24

SUBJECT: C and Data Structure

BRANCH(S): MCA (2 Yrs)

Time: 3 Hour

Max Marks: 100

Q.Code: N550

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions:

(2 x 10)

- Briefly write about conditional operator with a suitable example.
- What will be the output of the following C program?  

```
#include <stdio.h>
int main() {
    int *ptr;
    *ptr = 5;
    printf("%d", *ptr);
    return 0; }
```
- Write any three library functions to read from a file. If fopen() functions is not able to open a file, what does it returns?
- What value strcmp() function returns when two strings are: 1) same, 2) different?
- Predict the output of below program:  

```
#include <stdio.h>
int main()
{ int arr[5]; // Assume base address of arr is 2000 and size of integer is 32 bit
  printf("%u%u", arr+1, &arr+1);
  return 0; }
```
- Write the C code to allocate space dynamically to a two-dimensional array of size 20 x 30.
- Differentiate between linear and nonlinear data structure.
- Suppose a circular queue of capacity n elements is implemented with an array of n elements. Assume that the insertion and deletion operation are carried out using REAR and FRONT as array index variables, respectively. Initially, REAR = FRONT = -1. Write the conditions to detect queue full and queue empty.
- Consider n elements that are equally distributed in k stacks. In each stack, elements of it are arranged in ascending order (min is at the top in each of the stack and then increasing downwards). Given a queue of size n in which we have to put all n elements in increasing order. What will be the time complexity of the best-known algorithm?

- j) A single array A [1..MAXSIZE] is used to implement two stacks. The two stacks grow from opposite ends of the array. Variables top1 and top2 (top1 < top2) point to the location of the topmost element in each of the stacks. If the space is to be used efficiently, write the condition for "stack full".

### Part-II

**Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) (6 × 8)**

- a) Define data type. Explain primitive data types supported by C language with examples. Write a C program to print even numbers and odd numbers separately between 100 to 200.
- b) Write the syntax of different branching statements and explain their working with examples. Write a C program to print the reverse of a given integer.
- c) Differentiate between entry-controlled loop and exit controlled loop. Explain with syntax and example. Write a C program to multiply two matrices.
- d) Define recursive function. Write a C program to print the Nth Fibonacci number using recursion.  
Fibonacci numbers are: F0 = 0, F1 = 1, F2 = 1, F3 = 2, F4 = 3, F5 = 5 and so on
- e) Explain with suitable examples the scope, visibility, and lifetime of auto, external, static and register variables.
- f) Write a program to print the values of sin(x) in the interval 0 to 180 degrees in steps of 15 degrees. x is in degree. Do not use any library functions. The accuracy of sin(x) must not be less than 0.00001.
- g) Define a pointer. Discuss the declaration and initialization of the pointer variable. Define a function that uses pointers to take two matrices as input and returns their product.
- h) An electricity board charges the following rates for the use of electricity: for the first 200 units 80 paise per unit: for the next 100 units 90 paise per unit: beyond 300 units Rs. 1 per unit. All users are charged a minimum of Rs. 100 as meter charge. If the total amount is more than Rs. 400, then an additional surcharge of 15% of the total amount is charged. Write a C program to read the name of the user, number of units consumed and print out the charges.
- i) Differentiate properly the various modes of opening a file in C programming. Write a C program to create a file to store sequentially a list of products with the data – ID, Name, Rate, and Quantity.
- j) How many queues are needed to implement a stack? Consider the situation where no other data structure like arrays, linked list is available to you. Justify your answer.
- k) Evaluate the following postfix expression with single digit operands using a stack:  
 $8\ 2\ 3\ ^\ / \ 2\ 3\ * \ + \ 5\ 1\ * \ -$
- l) Show the detailed steps to convert given infix to postfix:  
I:  $p + q * r + (s * t + u) * v$

**Part-III**

**Only Long Answer Type Questions (Answer Any Two out of Four)**

- Q3** What is an array? Discuss different ways to declare and define one-dimensional and two-dimensional arrays with suitable examples. (16)  
Write a C program to enter a matrix of order  $m \times n$  then print the difference between sum of the elements of main diagonal and sum of the elements of first row of the matrix.
- Q4** Define function. Explain the different types of functions based on parameters. Write the definition of following functions without using library functions. (16)  
a. Compute the length of a string.  
b. Concatenate two strings.  
c. Convert a number from string format to integer format
- Q5** Differentiate between structure and union, with an appropriate example that demonstrates the storage of the data members. (16)  
You are required to rank the students of a classroom based on their marks in a particular subject. Define a student structure containing the members – ID, Name, Marks, and Rank. Provide user input facility for 10 students' data (ID, Name, Marks). Give the rank values as per the student ranking in the class. Define functions to print the data as a table.
- Q6** Compare stack and queue data structure? (16)  
Convert the following infix expression to its equivalent postfix expression:  
 $(A + B) / ((D - E) * F)$   
Evaluate the following Postfix expression:  
12, 7, 3, -, /, 2, 1, 5, +, \*, +

Registration No.:

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Total Number of Pages: 02

Course: MCA  
Sub\_Code: MCA01004

1<sup>st</sup> Semester Regular/Back Examination: 2023-24

SUBJECT: Operating System

BRANCH(S): MCA (2 Yrs)

Time: 3 Hour

Max Marks: 100

Q.Code: N583

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

**Part-I**

**Q1 Answer the following questions:**

**(2 x 10)**

- What do you mean by spooling? Give one example.
- Write the difference between multitasking and multi-programming.
- What is problem of priority scheduling? Write down its solution.
- Write the difference between light weight process and heavy weight process.
- At a particular time of computation the value of a counting semaphore is 7, then 20 P-operation and 15 V-operation were completed on the semaphore. What is the resulting value of semaphore?
- What is spinlock? Write down its advantages.
- What is Belady anomaly? Why it occurs?
- Let an instruction takes  $i$  ms and page fault takes additional  $j$  ms, If the average page fault occurs after every  $k$  instruction, then what is the average instruction time?
- If page size is 4KB and logical addresses 22 bit, what is the no. of entries in page table?
- A system has 6 identical resource and  $N$  processes competing for them. Each process can request at most 2 resources. What value of  $N$  could lead to deadlock?

**Part-II**

**Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)**

**(6 x 8)**

- Define process. Explain different states of a process with a neat diagram.
- What is process Control Block? List all the elements of process Control Block.
- Explain the importance of resource allocation graph in deadlock detection.
- How does the system detect thrashing? Once it detects thrashing, what can the system do to eliminate this problem?
- Define a process scheduler. State the characteristics of a good process scheduler.
- Define virtual memory. What are the implementation techniques of Virtual memory?
- Given a memory partition of 200 k, 500 k, 300 k, and 600 k (in order). How would each of first-fit, best-fit, worst-fit algorithms place processes of 212 k, 417 k, 112 k, and 426 k (in order)? Which algorithm makes the most efficient use of memory?
- What are the major activities of an operating system? What are the main advantages of layered approach to system design?
- What is critical section problem? List the three requirements that must be satisfied by critical section problem.

- j) A CPU generates 32-bit virtual addresses. The page size is 4 KB. The processor has a translation look-aside buffer (TLB) which can hold a total of 128 page table entries and is 4-way set associative. What is the minimum size of the TLB tag is?
- k) Define deadlock. State four condition of deadlock.
- l) Logical Address Space (LAS) = 128 KB  
Physical Address Space = 128 KB  
Page Size = 4KB  
Find logical address bit, physical Address bit, page offset bit no. of pages, no. of frames and page table size.

### Part-III

#### Only Long Answer Type Questions (Answer Any Two out of Four)

- Q3 a) Consider the following set of processes, with the arrival times and CPU burst time given in ms (8)

Process	Arrival Time	Burst Time
P1	0	5
P2	1	3
P3	2	3
P4	4	1

What is average turnaround time (average waiting and average response time) for these processes with the Shortest Remaining Processing Time First?

- b) Define operating system. Explain different types of operating system with its relative advantages and disadvantages. (8)

- Q4 a) Consider the following snapshot of a system: (8)

P\R	ALLOCATION				MAX				AVAILABLE			
	A	B	C	D	A	B	C	D	A	B	C	D
P <sub>0</sub>	0	0	1	2	0	0	1	2	1	5	2	0
P <sub>1</sub>	1	0	0	0	1	7	5	0				
P <sub>2</sub>	1	3	5	4	2	3	5	6				
P <sub>3</sub>	0	6	3	2	0	6	5	2				
P <sub>4</sub>	0	0	1	4	0	6	5	6				

Answer the following questions using the Banker's algorithm:

- i) What is the content of matrix Need?  
ii) Is the system in a safe state? If yes, what is the safe sequence? Show the detailed steps as per Banker's Algorithm.

- b) Define thread. What are similarities and differences between thread and process? (8)

- Q5 a) What is the producer consumer problem? Write down solutions for producer consumer problem? (8)

- b) Elucidate shared memory as Inter-process communication. Explain with example Peterson's Solution. Differentiate between counting and Binary semaphore and mention which semaphore is non negative. (8)

- Q6 a) A process has been allocated 3 pages frames. Assume that none of pages of the process are available in the memory initially. The process makes the following sequence page reference (8)

1	2	1	3	7	4	5	6	3	1
---	---	---	---	---	---	---	---	---	---

What is number of page fault occurs in FIFO, LRU and Optimal Page replacement algorithm?

- b) Differentiated between paging and segmentation with suitable example. (8)

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Total Number of Pages: 02

Course: MCA  
Sub\_Code: MCA01005

1<sup>st</sup> Semester Regular/Back Examination: 2023-24

SUBJECT: Database Engineering

BRANCH(S): MCA (2 yrs)

Time: 3 Hour

Max Marks: 100

Q.Code: N614

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions:

(2 x 10)

- What is a discriminator in ER model?
- How many n-ary relations can be formed over n sets having p elements each?
- What is lossless join decomposition?
- What is a foreign key? Give an example.
- Define 5NF.
- Differentiate candidate key vs. super key.
- What do you mean by ACID property of transactions?
- What are the various causes of database failure?
- What is deadlock in a database?
- What are the various states of a transaction in database?

Part-II

Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)

(6 x 8)

- Discuss in detail views and also creating, altering, destroying of views.
- Discuss the anomalies in designing a relational database.
- Consider the relation R(ABCDEFG) and set of functional dependencies,  $\{BCD \rightarrow A, BC \rightarrow E, A \rightarrow F, F \rightarrow G, C \rightarrow D, A \rightarrow G\}$ . Decompose up R up to 3<sup>rd</sup> Normal Form (3NF).
- Let's consider a relational table R with attributes A, B, C, D, and E. The set of functional dependencies (FDs) defined on relation R, are  $FDs = \{A \rightarrow B; BC \rightarrow E; ED \rightarrow A\}$ . Decompose relation R up to Boyce-Codd Normal Form (BCNF).
  - Write a relational algebra (RA) query for the following SQL statement:  
Select Roll No, Name, Age from Student where Branch='IT' and Age>15;
  - Write a tuple relational calculus (TRC) query for the following SQL statement:  
Select Instructor ID from Instructor where Salary>100,000;
- Write a correlated sub-query to retrieve employee details of an organization earning n<sup>th</sup> highest salary.
  - Express  $R \div S$  in terms of  $\pi$ ,  $\times$ , and  $-$  operators.
- Differentiate nested loop, hash join and merge join.
- Explain about Integrity Constraints over relations in detail.

- i) Consider the transactions T1, T2, and T3 and the schedules S1 and S2 given below. Test for conflict serializability of S1 and S2.  
 T1 : r1(X); r1(Z); w1(X); w1(Z)  
 T2 : r2(Y); r2(Z); w2(Z)  
 T3 : r3(Y); r3(X); w3(Y)  
 S1 : r1(X); r3(Y); r3(X); r2(Y); r2(Z); w3(Y); w2(Z); r1(Z); w1(X); w1(Z)  
 S2 : r1(X); r3(Y); r2(Y); r3(X); r1(Z); r2(Z); w3(Y); w1(X); w2(Z); w1(Z)
- j) Consider the following database schedule with two transactions, T1 and T2.  
 S = r2(X); r1(X); r2(Y); w1(X); r1(Y); w2(X); a1; a2  
 where ri(Z) denotes a read operation by transaction Ti on a variable Z, wi(Z) denotes a write operation by Ti on a variable Z and ai denotes an abort by transaction Ti. Comment on the following properties of the schedule:  
 cascadelessness, recoverability, deadlock, conflict serializability.
- k) Explain about aggregate operators in SQL with examples.
- l) Explain about remote backup systems.

### Part-III

#### Only Long Answer Type Questions (Answer Any Two out of Four)

- Q3** Construct an ER-diagram for a company is organized into departments. Each department has unique name, a unique number, and a particular employee who manages the department. We keep track of the start date when that employee began managing the department. A department may have several locations. A department controls a number of projects, each of which has a unique number, and a single location. We store each employee's name, social security number, address, salary, sex, and birth date. An employee is assigned to one department, but may work on several projects, which are not necessarily controlled by the same department. We keep track of the number of hours per week that an employee works on each project. We also keep track of the direct supervisor of each employee. We want to keep track of the dependents of each employee for insurance purposes. We keep each dependent's first name, sex, birth date, and relationship to the employee. Write the steps to convert an ER-diagram into equivalent relational tables. Convert the above ER-diagram into equivalent relational tables. (16)
- Q4** Explain 3-schema database architecture. Discuss the roles of database DB users and DB administrators. (16)
- Q5** What is a lock in DBMS? Describe two phase locking (2PL) protocol. What are the variations of the 2PL protocol? Discuss about the cascadelessness, recoverability, deadlock, conflict serializability of all variations. (16)
- Q6** Write short notes on any two of the followings: (16)
- i. Cursor vs. Trigger
  - ii. Query optimization
  - iii. Data ware house
  - iv. Log based Database Recovery