



ATTEMPT THIS (SUBJECTIVE) ON THE SEPARATE ANSWER SHEET PROVIDED

Q#2. [7 + 5 = 12] Proofs

- a. Use Mathematical Induction to prove the following formula for non-negative integers

$$1^2 + 2^2 + 3^2 + 4^2 + \dots + n^2 = \frac{n(n+1)(2n+1)}{6}, \text{ for } n \geq 1$$

- b. Proof that $7n+2$ will always be even if and only if n is even.

Q#3 [10 + 10 = 20] Summations and Recursive Functions.

- a. What is the next term in the sequence: {3, 10, 38, 150, 598 ...}
Express above sequence using recurrence relations. Also clearly write initial value(s).
- b. Evaluate following summations using $n=2$, $m=3$, $c=4$ and $b=5.2$

$$\sum_{j=1}^m \sum_{l=1}^n (l^2 - [5b]l) + 2c$$

Q#4. [15 + 13 = 28] Graphs.

- a. What is meant by graph coloring problem? Draw the graphs C_8 , W_8 , K_6 , $K_{4,3}$ and determine their chromatic number.
- b. What is difference between a graph and circuit. Explain Euler and Hamiltonian path/circuit. Explain each with examples and their applications.

Q#5. [4*3 = 12] Using counting concepts, answer the following:

- a. How many different strings can be made by reordering the letters of the word SUCCESSION?
- b. Suppose that there are total of nine runners in a race. The winner receives a gold medal, the second place holder receives a silver medal, and the third-place holder receives a bronze medal. How many different ways are there to award these medals, if all possible outcomes of the race can occur and there are no ties?
- c. How many permutations of the letters "ABRACADABRA" contain the string "ABRA"?
- d. A group of 20 people have been trained as physicians to go on a scientific discovery. How many ways are there to select a crew of five people to go on this mission (assuming that all will have the same job)?

Q#6. [2+3+3= 8] Sets

Let $A = \{1,2,3,7\}$ $B = \{1,4,7,10\}$ under the universe of first ten natural numbers. Using these, answer the following:

- a. Represent sets A and B in bitstrings.
- b. Calculate $A-B$, \bar{A} , $A \cap B$.
- c. Represent $A-B$, \bar{A} , $A \cap B$ using vein diagrams.



UNIVERSITY OF THE PUNJAB

B.S. in Computer Science / 2nd Year : Annual – 2022

Subject: Discrete Mathematics

Paper: 6

Time: 30 Min. Marks: 20

Roll No. in Fig.

Roll No. in Words.

Signature of Supdt.

This Paper will be collected back after expiry of time limit mentioned above, then Subjective paper shall be attempted.

ATTEMPT THIS PAPER ON THIS QUESTION SHEET ONLY.

Q.1. Fill in the Blanks Answer in the provided space. (10x2=20)

1. "The product of two negative real numbers is not negative". The corresponding quantified statement for this expression can be _____

2. The least common multiple of $3^{18}2^57^2$ and $2^43^{13}5^3$ is _____.
3. The greatest-common-divisor of $3^{18}2^57^2$ and $2^43^{13}5^3$ is _____.
4. Let C be the set {1, 2, 3, 4}. In CxC: The ordered pairs that respect the relation $R = \{(a, b) \mid b \text{ divides } a\}$ are: _____

5. A transitive relation is _____

6. The minimum number of students required in a "Object Oriented Programming" class to be sure that at least eight will receive the same grade, if there are five possible grades, A, B, C, D, and F will be _____.
7. If -14 is divided by 4, the quotient and remainder will be _____ and _____ respectively.
8. If $((p \vee q) \wedge \neg p)$ is true then the value of q will be _____ using _____ rule of inference.
9. The cardinality of the set consisting of odd integers less than 12 will be _____.
10. The truth value of given statement 'If 7 is prime then 2 is even' is: _____.



ATTEMPT THIS (SUBJECTIVE) ON THE SEPARATE ANSWER SHEET PROVIDED

NOTE: Attempt ALL questions.

Q.2. (a) Assume "file.txt" has following text. What will be the output of the given code? (2x5=10)

"PUCIT is;; the;;largest institution, of;; higher, learning; in; Pakistan."

```
#include<iostream>
#include<fstream>
#include<string>
using namespace std;
int main()
{
    fstream file;
    string s;
    file.open("file.txt", ios::in);
    int i = 0;
    while (i<5)
    {
        getline(file, s, ',');
        i++;
    }
    cout << s << endl;
}
```

(b) What will be the output of the following program?

```
#include <iostream>
#include <fstream>
#include <string>
using namespace std;
int main()
{
    fstream file; string s;
    file.open("file.txt", ios::out);
    file << "Dirilis Ertugrul is a Turkish historical fiction";
    file.close();
    file.open("file.txt", ios::in);
    file.seekg(3);
    file >> s;
    cout <<s<< endl;
}
```

Q.3. Complete the following code.

(5)

```
#include<iostream>
using namespace std;
class Sale
{
    //PROVIDE DECLARATION OF FRIEND FUNCTION FOR << OPERATOR
    //PROVIDE DECLARATION OF FRIEND FUNCTION FOR >> OPERATOR

private:
    int receiptNum;
    double saleAmount;
public:
    Sale(int, double); //constructor
};
Sale::Sale(int num, double sale)
{
    receiptNum = num;
    saleAmount = sale;
}
//Provide definition for << operator
//Provide definition for >> operator

int main()
{
    Sale aShirt(1567, 39.95);
    //call overloaded << and >> operator functions
    return 0;
}
```

Q.4. Create a Job Exception class with attributes: job object (object of Job class) and error message (string). (7)

Create a Job class consisting of Job_ID and fee of the Job. You must implement the following functions:

- insertion and extraction operators
- In insertion operator function, validate the input. If the Job fee is below \$250, then create a JobException object and throw it.

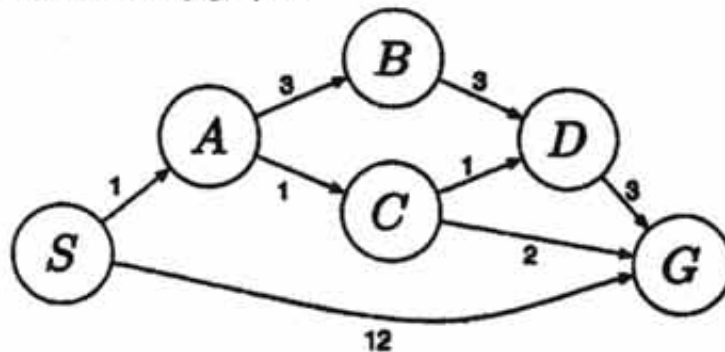
Write a main() function that declares an array of eight Job objects. If a JobException object is thrown during the data entry for any Job, require the user to enter data for a new Job, and replace the invalid Job.

Q.5. Give an initially empty hash table with capacity 11 and hash function $H(x) = x \% 11$. Keys 0,1,8,9 are already in the table. Insert keys 52,44,56,53,61,64 (in that order). (5)

Q.6. (a) Insert the following numbers into a binary search tree. Draw the tree after all insertions are complete. (2x4=8)
5,16,17,12,10,9,0,3

(b) Delete 5 from the final tree that you drew in (a) and draw the final tree.

Q.7. Consider the following graph. (10)



Answer the following questions about the search problem shown above. Break any ties alphabetically. For the questions that ask for a path, please give your answers in the form 'S - A - D - G.'

(a) What path would breadth-first graph search return for this search problem?

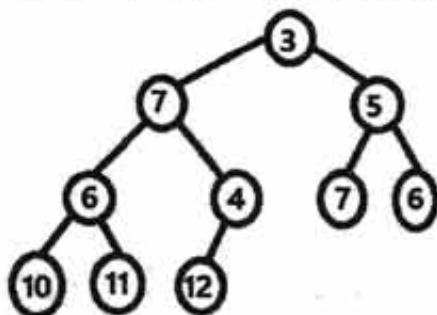
(b) What path would depth-first graph search return for this search problem?

Q.8. (a) Insert the following 8 numbers into a max heap. Draw a new tree for each heap insertion. (4x4=16)
10,12,13,1,2,3,18,0

(b) Find the height of the tree that you draw in (a).

(c) Perform exactly two deleteMax() operations on the heap that you draw in (a). Draw the resulting trees.

(d) Consider the following min heap implemented in an array. It is not quite correct. To make it a proper max heap exactly one swap must occur. What two numbers (child and parent) need to be swapped in order to make it a max heap? Place check marks next to the two numbers that need to be swapped.





UNIVERSITY OF THE PUNJAB

B.S. in Computer Science / 2nd Year : Annual – 2022

Subject: Object Oriented Programming &

Data Structures and Algorithms

Paper: 7

Time: 30 Min. Marks: 14

Roll No. in Fig.

Roll No. in Words.

This Paper will be collected back after expiry of time limit mentioned above, then Subjective paper shall be attempted

ATTEMPT THIS PAPER ON THIS QUESTION SHEET ONLY.

Signature of Supdt.:

Q.1. Choose the correct option.

(14x1=14)

- What differentiates a circular linked list from a normal linked list?
 - You cannot have the 'next' pointer point to null in a circular linked list
 - It is faster to traverse the circular linked list
 - You may or may not have the 'next' pointer point to null in a circular linked list
 - Head node is known in circular linked list
- You are given pointers to first and last nodes of a singly linked list, which of the following operations are dependent on the length of the linked list?
 - Delete the first element
 - Insert a new element as a first element
 - Delete the last element of the list
 - Add a new element at the end of the list
- Space complexity for an adjacency list of an undirected graph having large values of V (vertices) and E (edges) is _____
 - $O(E)$
 - $O(V*V)$
 - $O(E+V)$
 - $O(V)$
- The result of evaluating the postfix expression 5, 4, 6, +, *, 4, 9, 3, /, +, * is?
 - 600
 - 350
 - 650
 - 588
- What is the maximum height of an AVL tree with p nodes?
 - p
 - $\log(p)$
 - $\log(p)/2$
 - $\frac{p}{2}$
- Consider the following operation performed on a stack of size 5.
 - Push(1);
 - Pop();
 - Push(2);
 - Push(3);
 - Pop();
 - Push(4);
 - Pop();
 - Pop();
 - Push(5);
- After the completion of all operation, the number of elements present in stack is?
 - 1
 - 2
 - 3
 - 4
- We cannot make an instance of an abstract base class
 - TRUE
 - FALSE
 - Can be true and false
 - Can not say

9. Consider the following code. Can we access base3() using the sptr pointer

```
#include<iostream>
using namespace std;
class Ancestor
{
    private:
        void base1();
    protected:
        void base2();
    public:
        void base3();
};
class Successor: public Ancestor
{
    private:
        void derived1();
    protected:
        void derived2();
    public:
        void derived3();
};
void main()
{
    Successor* sptr = new Successor();
}
```

- a) No
- b) Yes

10. Which member function doesn't require any return type?

- a) Static
- b) Copy Constructor
- c) Const
- d) Constructor and Destructor

11. C++ abstract class can contain

- a) Pure virtual function
- b) Non-virtual function
- c) Only pure virtual function
- d) Both pure virtual and non-virtual function

12. Which of the following is incorrect regarding friend functions?

- a) When you overload a unary operator you have to pass one argument.
- b) When you overload a binary operator you have to pass two arguments.
- c) Friend function can access private members of a class directly
- d) These functions are members of the class and they have 'this' pointer.

13. Which keyword is used to handle the exception?

- a) Try
- b) Throw
- c) Catch
- d) None of the above

14. Which is also called as abstract class?

- a) Virtual function
- b) Derived class
- c) Pure virtual function
- d) None of the mentioned



ATTEMPT THIS (SUBJECTIVE) ON THE SEPARATE ANSWER SHEET PROVIDED

NOTE: Attempt any FOUR questions. All questions carry equal marks.

Q.2. Reading Comprehension: Read the passage, then answer the questions below. (20)

When you imagine the desert, you probably think of a very hot place covered with sand. Although this is a good description for many deserts, Earth's largest desert is actually a very cold place covered with ice: Antarctica.

In order for an area to be considered a desert, it must receive very little rainfall. More specifically, it must receive an average of less than ten inches of precipitation—which can be rain, sleet, hail, or snow—on the ground every year. Antarctica, the coldest place on earth, has an average temperature that usually falls below the freezing point. And because cold air holds less moisture than warm air, the air in Antarctica does not hold much moisture at all. This is evident in the low precipitation statistics recorded for Antarctica. For example, the central part of Antarctica receives an average of less than 2 inches of snow every year. The coastline of Antarctica receives a little bit more—between seven and eight inches a year. Because Antarctica gets so little precipitation every year, it is considered a desert.

When precipitation falls in hot deserts, it quickly evaporates back into the atmosphere. The air over Antarctica is too cold to hold water vapor, so there is very little evaporation. Due to this low rate of evaporation, most of the snow that falls to the ground remains there permanently, eventually building up into thick ice sheets. Any snow that does not freeze into ice sheets becomes caught up in the strong winds that constantly blow over Antarctica. These snow-filled winds can make it look as if it is snowing. Even though snowfall is very rare there, blizzards are actually very common on Antarctica.

Questions

1) The main purpose of paragraph 1 is to

- A. accept a conclusion
- B. introduce an argument
- C. provide a brief history
- D. deny a common belief

2) The best title for this passage would be

- A. Earth's Many Deserts
- B. Antarctica: The Coldest Place on Earth
- C. A Desert of Ice
- D. Unusual Blizzards

3) Africa's Sahara Desert is the second-largest desert on earth. Based on the information in the passage, what characteristic must the Sahara share with Antarctica?

- A. low temperatures
- B. high temperatures
- C. frequent blizzards
- D. low precipitation

4) As used in paragraph 2, which is the best definition for precipitation?

- A. moisture in the air that falls to the ground
- B. any type of weather event
- C. weather events that only happen in very cold areas
- D. a blizzard that occurs in areas with limited snowfall

5) In paragraph 2 the author writes, "And because cold air holds less moisture than warm air, the air in Antarctica does not hold much moisture at all." Using this information, it can be understood that

- A. air in Africa holds more moisture than the air in Antarctica
- B. air surrounding a tropical island holds less moisture than the air in Antarctica
- C. air in the second floor of a house is typically warmer than air on the first floor
- D. air at the mountains is typically colder than the air at the beach

6) Based on the information in the final paragraph, it can be understood that blizzards in Antarctica are mainly the result of

- A. freezing cold temperatures
- B. large amounts of snowfall
- C. low amounts of precipitation
- D. strong winds

Q3. Write a memo to your boss and explain how the new software for inventory will help the company.

(20)

Q4. Write an essay of about 300-400 words on ONE of the following topics.

(20)

1. Social Media
2. Advertisements create unrealistic expectations
3. Mass media and pandemic panic

Q5. Write a letter to the successful candidate of the interview and inform him/her when to report for the job.

(20)

Q6. How awareness of cross cultural communication helps an employee to become a successful communicator?

(20)

Q7. Write a negative letter to the client and let him/her know that your bank would not extend their credit limit. Give valid reasons for your refusal.

(20)



UNIVERSITY OF THE PUNJAB

B.S. in Computer Science / 2nd Year : Annual – 2022

Subject: Communication Skills & Technical and
Business Writing

Paper: 8

Time: 30 Min. Marks: 20

Roll No. in Fig.

Roll No. in Words.

This Paper will be collected back after expiry of time limit mentioned above, then Subjective paper shall be attempted.

ATTEMPT THIS PAPER ON THIS QUESTION SHEET ONLY.

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Q.1. a) Confusing words

(5)

- i. You need to begin every sentence with a _____ letter.
a) capitol
b) capital
- ii. The Sahara _____ is located in Africa.
a) desert
b) dessert
- iii. Are all my students _____ ?
a) hear
b) here
- iv. Why does Dave always _____ his socks?
a) loose
b) lose
- v. I haven't seen him _____ over five years.
a) since
b) for

b) Choose the correct answer.

(5)

- i. The man was _____ for murder.
a) hung
b) hanged
c) hang
- ii. I _____, him a moment ago.
a) saw
b) have seen
- iii. He _____, in 1995.
a) has graduated
b) graduated
c) had graduated
- iv. He _____, ill for about a month.
a) had been
b) has been
c) is
- v. That house isn't big enough for us, and _____, it's too expensive.
a) furthermore
b) hence
c) although

c) Fill in the blanks with an appropriate adjective.

(5)

- i. I cannot walk any _____.
a) farther
b) further
c) Either could be used here
- ii. He fishes with _____ success than I do.
a) great
b) greater
c) greatest
- iii. There were _____ applicants than expected.
a) fewer
b) less
c) lesser
- iv. I have _____ interest in politics.
a) little
b) less
c) lesser
- v. When the old woman became _____ she began to move about.
a) stronger
b) more strong

d) Choose the correct word

(5)

- i. He is _____ rich.
a) very
b) much
c) so
- ii. The journey was _____ uncomfortable.
a) rather
b) fairly
c) fair
- iii. He plays hockey very _____.
a) well
b) good
- iv. He narrated the incident in _____.
a) detail
b) details
- v. He is getting _____ day by day.
a) well
b) better
c) best



UNIVERSITY OF THE PUNJAB

B.S. Computer Science / 2nd Year : Annual – 2022

Roll No.

Subject: Theory of Automata & Formal Languages

Paper: 9

Time: 2 Hrs. 30 Min. Marks: 80

ATTEMPT THIS (SUBJECTIVE) ON THE SEPARATE ANSWER SHEET PROVIDED

NOTE: Attempt ALL questions.

- Q 2. Write regular expression for the language that must contain at most two a , over input alphabets $\Sigma = \{a, b, c\}$. Also draw the corresponding DFA. [7+8=15 marks]
- Q 3. Design mealy and moore machine for 2's complement. [8+7=15 marks]
- Q 4. Convert following CFG to CNF, and also draw the corresponding PDA [10 marks]
- $S \rightarrow BSA|BS|AS$
 $B \rightarrow aAS|a|e|aa$
 $A \rightarrow SbS|A|bb$
- Q 5. Write the Context Sensitive Grammar for the language $a^n c^{2n} d^n; n \geq 1$, and draw the TM for the language as well. [10+10=20 marks]
- Q 6. Write the Context Free Grammar for the language $a^n c^n b^{2m}; n \geq 2, m \geq 1$ and draw the corresponding PDA. [10+10=20 marks]



UNIVERSITY OF THE PUNJAB

B.S. in Computer Science / 2nd Year : Annual – 2022

Subject: Theory of Automata & Formal Languages

Paper: 9

Time: 30 Min. Marks: 20

Roll No. in Fig.

Roll No. in Words.

Signature of Supdt.

This Paper will be collected back after expiry of time limit mentioned above, then Subjective paper shall be attempted.

ATTEMPT THIS PAPER ON THIS QUESTION SHEET ONLY.

Q.1. Fill in the blanks.

(10x2=20)

1. Regular-languages and context-free languages are classified as Type ___ and ___ languages.
2. Let the class of language accepted by NFA be L_1 and the class of languages represented by regular expressions be L_2 then power of L_1 is _____ in comparison to L_2 .
3. Suppose a language L_1 has 4 states and L_2 has 2 states. After using the cross-product construction method, we have a machine M that accepts $L_1 \cap L_2$. The total number of states in M would be _____.
4. DFA and NFA are equivalent in power Answer in Yes or No. _____.
5. Definition of Turing Machine consists of _____

6. Pumping lemma in regular languages is used for _____

7. Language hierarchy classifies language in _____ categories which are _____

8. An inherently ambiguous grammar is _____

9. Context-sensitive languages are closed under _____
_____ operations.
10. DFA can be converted to RE using _____.



ATTEMPT THIS (SUBJECTIVE) ON THE SEPARATE ANSWER SHEET PROVIDED

NOTE: Attempt any TWO questions from each Section.

SECTION – I (LINEAR ALGEBRA)

Question 3 Find an orthogonal matrix P that diagonalizes $A = \begin{bmatrix} 4 & 2 & 2 \\ 2 & 4 & 2 \\ 2 & 2 & 4 \end{bmatrix}$. (20marks)

Question 4 Find the rank and nullity of $A = \begin{bmatrix} -1 & 2 & 0 & 4 & 5 & -3 \\ 3 & -7 & 2 & 0 & 1 & 4 \\ 2 & -5 & 2 & 4 & 6 & 1 \\ 4 & -9 & 2 & -4 & -4 & 7 \end{bmatrix}$. Also write down the general solution of the system. (20marks)

Question 5 Let R^4 have the Euclidean inner product. Use the Gram– Schmidt process to transform the basis $\{u_1, u_2, u_3, u_4\}$ into an orthonormal basis. $u_1 = (0, 2, 1, 0), u_2 = (1, -1, 0, 0), u_3 = (1, 2, 0, -1), u_4 = (1, 0, 0, 1)$ (20marks)

SECTION – II (PROBABILITY AND STATISTICS)

Question 6 Suppose that the time, in hours, taken to repair a heat pump is a random variable X having a gamma distribution with parameters $\alpha = 2$ and $\beta = 1/2$. What is the probability that the next service call will require

a) at most 1 hour to repair the heat pump? (10marks)

b) at least 2 hours to repair the heat pump? (10marks)

Question 7 The probability that a patient recovers from a delicate heart operation is 0.8. What is the probability that

a) exactly 2 of the next 3 patients who have this operation survive? (10marks)

b) all of the next 3 patients who have this operation survive? (10marks)

Question 8 The length of time Y in minutes required to generate a human reflex to tear gas has density

$$f(Y) = \begin{cases} \frac{1}{4} e^{-Y/4}, & 0 \leq Y < \infty \\ 0, & \text{elsewhere} \end{cases}$$

a) What is the mean time to reflex? (10marks)

b) Find $E(Y^2)$ and $Var(Y)$. (10marks)



UNIVERSITY OF THE PUNJAB

B.S. in Computer Science / 2nd Year : Annual – 2022

Subject: Linear Algebra & Probability and Statistics

Paper: 11

Roll No. in Fig.

Roll No. in Words.

Time: 30 Min. Marks: 20

This Paper will be collected back after expiry of time limit mentioned above, then Subjective paper shall be attempted.

ATTEMPT THIS PAPER ON THIS QUESTION SHEET ONLY.

Signature of Supdt.:

Q.1. Fill in the blanks with appropriate answers.

(10x1=10)

1. The rank of the matrix $(m \times n)$ where $m < n$ cannot be more than-----?
2. If a square matrix B is skew symmetric then $B^T =$ -----?
3. The dimension of a matrix with m rows and n columns is -----.
4. A cyclic group is always -----group.
5. A non-empty set A is called an algebraic structure with respect to -----operation.
6. If the dimensions of subspaces u_1 and u_2 of a vector space U are respectively 3 and 4, and $\dim(u_1 \cap u_2) = 1$, then dimension of $(u_1 + u_2) =$ -----?
7. The dimension of a row vector can be written as-----.
8. The number of independent vectors defines ----- of a vector space.
9. If A and B are non-zero square matrices, then $AB = 0$ implies that A and B are-----.
10. If the vectors $e_1 = (1,0,2)$, $e_2 = (1,0,1)$ and $e_3 = (-2,0,1)$ form an orthogonal basis of R^3 , then the vector $u = (4,3,-3) \in R^3$ can be expressed as-----.

Q.2. Fill in the blanks with appropriate answers.

(10x1=10)

1. If 35 is removed from the data, 30,34,35,36,37,38,39,40, then mean increases by -----.
2. The expected value or ----- of a random variable is the center of its distribution.
3. The square root of the variance is called -----deviation.
4. Chebyshev's inequality states that the probability of a 'six sigma' event is less than -----.
5. The binomial distribution is based on-----trials.
6. For 9 Bernoulli trials, what will be the mean of trials when probability of failure is 0.56?-----.
7. Normal distribution is used for----- random variable.
8. If the coefficient of variation is 100 and mean is 25, then standard deviation is-----.
9. What is the probability of getting 9 from two throws of a dice?-----.
10. In a lottery, there are 15 prizes and 20 blanks. A lottery is drawn at random, what is the probability of getting a prize?-----.