

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

SWE 4101: Introduction to Software Engineering

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

- 1. a) Describe a conceptual file system that achieves the typical storage cataloging purpose – ‘Directory contains Directories and Files, File comprises of few storage block(s)’. 7
(CO1)
(PO1)
- b) How does a computer boot up? 8
(CO1)
(PO1)
- c) A novice user used the commands `ls` and `cd` as shown in Figure 1 and got a message: ‘Error: not a directory’.

```
# pwd
/
#ls
User      bin      etc      home     dev      var      myfileDirDev
# cd myfileDirDev
Error: not a directory
```

Figure 1: Code Snippet for Question 1.c)

- i. What mistake has s/he done? What actions does the user need to perform if s/he wants to investigate the contents of `myfileDirDev`? 3
(CO1)
(PO1)
- ii. The user typed `ls -l` in the command prompt. What output s/he will see? (two line sample output will be enough for the demonstration) 2
(CO1)
(PO1)
- iii. Now, write a program that will take the output of `ls -l` as input and will print the number of files and directories (you can assume any algorithmic artefact as needed without implementation, for example `getLine()`, etc.). 5
(CO2)
(PO2)

- 2. a) Describe Hard Disk and its storage mechanism. 10
(CO1)
(PO1)
- b) Describe Flash storage technology. How do size and access time vary based on NAND and NOR packaging? 10
(CO1)
(PO1)
- c) Answer the following questions: 1x5
 - i. Why do computers use Cache Memory? (CO1)
 - ii. How many bits make a kilo byte? (PO1)
 - iii. Why don't we use Flash memory as RAM?
 - iv. Why is it hard by make more than 1GB processor in a single chip?
 - v. What are the components that make a computer system?

- 3. a) Describe two phishing attack scenarios. 7
(CO1)
(PO1)
- b) Describe XSS Attack and SQL Injection. Describe how those attacks can be prevented. 8
(CO1)
(PO1)
- c) Describe Virus and their way of propagations in executables. Describe IAT and ELF (Entry point) Virus. 10
(CO1)
(PO1)

- 4. a) Which things are patentable? Describe in light of first three sections of "Title 35 of the United States Code". 7
(CO1)
(PO1)
- b) How do IT organizations generate revenue from patents, sometimes even from the products of other companies? Briefly provide two examples of such revenue generation. 8
(CO1)
(PO1)
- c) Describe HIPAA and FISMA for Information and Cyber Security. 10
(CO1)
(PO1)

- 5. a) What are the things/tasks you do when you plan and complete a Tour (visit a new place)? Do you improve yourself in repetitive tours? What things do you expect to improve? Do you find any resemblance of your activities with that of a software development process? 5
(CO1)
(PO1)
- b) Describe the tasks of compiler, assembler and linker in producing a binary. 10
(CO1)
(PO1)
- c) Answer the followings: 2x5
 - i. Why are AJAX rich applications more vulnerable to XSS attacks? (CO1)
 - ii. Why quick and on demand SQL writing are prone to SQL Injection? (PO1)
 - iii. Internet is predominated by world wide web (www). Write two applications or protocols that are not www.
 - iv. How is a URL resolved by the browser?
 - v. Can we write a code and generate executable without an IDE? Explain.

- 6. a) Describe the task of miner in a block chain. 7
(CO1)
(PO1)
- b) What is a Merkel Tree in peer-to-peer network? How is the Merkel Tree used in Block chain? 8
(CO1)
(PO1)
- c) Answer the following questions: 2x5
 - i. How do block chain invalidate double spending? (CO1)
 - ii. How is PoW byzantine fault tolerant? (PO1)
 - iii. 'Increased hash rate means the block chain is more secured.' – Explain.
 - iv. What hashing algorithm is used in Bitcoin?
 - v. Write a simple hashing technique.

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DURATION: 3 HOURS

FULL MARKS: 150

CSE 4105: Computing for Engineers

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SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

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FULL MARKS: 150

CSE 4107: Structured Programming I

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) There are 32 participating countries divided in four groups in the FIFA World Cup. Your task is to store the name of the teams group-wise along with the ranking of each team. 3×4
(CO1)
- i. Write a structure named **“TeamInfo”** that can store the name and the ranking of a team. (PO1)
 - ii. Declare an array of that structure to store the group-wise information. (Figure 1 shows a pictorial representation of the array).
 - iii. Write a program that reads the information and stores them into the array.

[team1, 13]	[team5, 2]	...	[team25, 1]	[team29, 20]
[team2, 14]	[team6, 6]	...	[team26, 3]	[team30, 22]
[team3, 12]	[team7, 8]	...	[team27, 4]	[team31, 17]
[team4, 15]	[team8, 5]	...	[team28, 9]	[team32, 23]

Figure1: Representation of array for Question 1.a)

- b) Based on the information stored in the question 1.a), build a scheduler using C program, that creates a group stage game schedule following round-robin procedure, where each team meets every other participant of their respective group. 13
(CO3)
(PO2)
- Consider the following criteria while creating the schedule:
- One game will be played every day without a break.
 - First game will start on 01-Nov-2022.
 - While printing the team’s name for each of the games, the name of the team with better ranking (lower rank value) will be printed first.
 - Follow the format provided in Figure 2 for printing the schedule.

Game 1: team1 vs team2 (01-Nov-2022)
Game 2: team3 vs team1 (02-Nov-2022)
Game 3: team1 vs team4 (03-Nov-2022)

Figure 2: Sample schedule of first 3 games

2. a) Due to the lack of space in the display board, the FIFA World Cup committee decided to display the shorter version of the player names. The names are shortened by the following guidelines: 10
(CO3)
(PO2)
- Only the first name and last name are considered for the players.
 - Full last name of the player with capitalized first letter is displayed first.
 - Second part of the name contains capitalized first and last letter of first name.
- For example:
- If a player’s name is Mohammad salah, his name will be displayed as: Salah MD
 - If a player’s name is Lionel messi, his name will be displayed as: Messi LL
- Construct a user-defined function that takes two strings as parameters representing the first and last name of a player. The function prints the shorter version of the player’s name.
- b) Saudi Arabia made history in the FIFA World Cup 2022 by defeating Argentina. Being satisfied with the result, the prince of Saudi Arabia announced rewards for the players depending on the number of goals they scored in the tournament. The reward is calculated based on the following algorithm: 15
(CO3)
(PO2)

```

1) input n (number of goals)
2) reward = n x 1000
3) repeat steps 4 to 6 if n is greater than 1
4)     if n is odd then n = 3n + 1
5)     else n = n/2
6)     reward = reward + ( n x 1000)
7) return reward

```

Figure 3: Algorithm for determining the reward for Question 2.(b)

For example:

- If anyone scored 4 goals, his reward will be:
7000 = 4000 + 2000 + 1000
- If anyone scored 3 goals, his reward will be:
49000 = 3000 + 10000 + 5000 + 16000 + 8000 + 4000 + 2000 + 1000

Your task is to construct a system using C program that reads the number of goals scored by a player and calculates his reward.

3. In a soccer game, an offside is a case when a player receives the ball from a teammate without having at least two opponent players between him and the goal. Figure 4 explains two scenarios representing an offside and a non-offside case. In these scenarios, the players of the two teams are represented using circles and squares. The arrow represents the direction of passing the ball. In both cases, the ball is sent from circle side to square side.

5+20
(CO3)
(PO2)

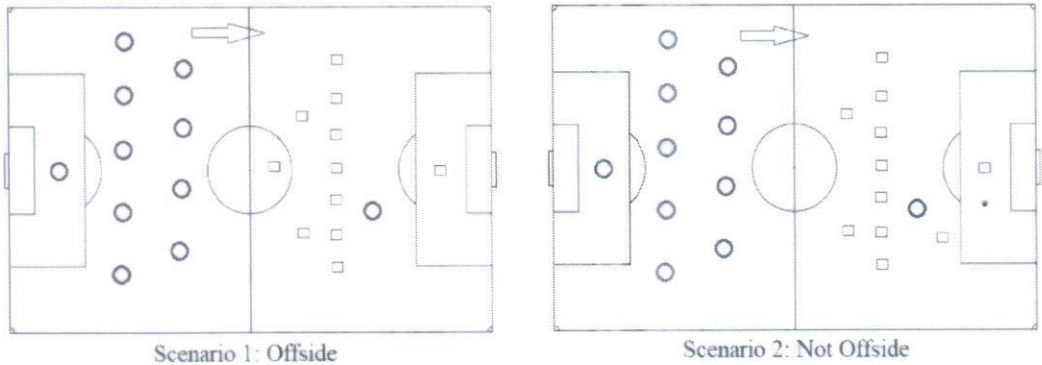


Figure 4: Offside scenarios for Question 3

- In the first scenario, there is only one square player between the last circle player and the goal post. That is why it is considered as offside.
- In the second scenario, there are two square players between the last circle player and the goal post. That is why it is not considered as offside.

You will be provided with the position of all 22 players of the field and the direction of the balls passed. The position of the players will be represented by a pair of numbers (x, y), a coordinate of a 2D plane. The bottom left corner of the field has a coordinate of (0,0) and the top-right corner of the field has a coordinate of (100,60). The input format is described below:

- The first line contains 11 pairs of numbers representing the position of the players of the circle side
- The second line contains 11 pairs of numbers representing the players from square side
- The third line contains a single character representing the direction of pass. A '>' represents the pass from circle side to square side and a '<' represents the pass from square side to circle side.

Answer the following questions:

- Use a 3-dimensional array (2 x 11 x 2) to read the coordinates of the players into the array.
- Construct an automated offside detector using C program, that given the input as described above, detects whether a certain pass is offside or not.

A sample input and output is presented in Table 1.

Table 1: Sample input and output for Question 3

Input	Output
10,30 20,10 20,20 20,30 20,40 20,50 40,15 40,25 40,35 40,45 80,20 55,30 60,10 60,40 65,15 65,20 65,25 65,30 65,35 65,40 65,45 95,30 >	Offside
10,30 20,10 20,20 20,30 20,40 20,50 40,15 40,25 40,35 40,45 80,20 85,15 60,10 60,40 65,15 65,20 65,25 65,30 65,35 65,40 65,45 95,30 >	Not Offside

4. a) Consider the code snippet provided in Figure 5:

3×4
(CO3)
(PO2)

```
#include<stdio.h>
void f1(char *str){
    if(*str){
        printf("%c",*str);
        //Recursive Call
        printf("%c",*str);
    }
}
int main(){
    f1("FIFA-2022");
}
```

Figure 5: Code snippet for question 4.a)

Find the output of the program if you replace the following statements in the place of “// Recursive Call”:

- i. f1(str+1);
- ii. f1(str++);
- iii. f1(++str);

b) To create a specific pattern using the spectators in 2022 World Cup, FIFA decided to allocate seats to specific fan base maintaining the following criteria:

13
(CO3)
(PO2)

- If the topmost row contains n spectators, then the next row will contain $(n - 1)$ spectators
- Once the spectator number reaches to 1, then it starts increasing by 1 in the following rows until it reaches n spectators

A sample seat allocation where top row contains 5 spectators is presented in Figure 6.

```
#####
#####
####
###
##
#
##
###
####
#####
#####
```

Figure 6: Sample seat distribution for question 4.b)

Construct a recursive function that takes a number n , indicating the number of seats in the top row and prints the seat distribution pattern.

5. a) Assume that you want to build an information system using files to store some basic information about each team in the FIFA World Cup. The system needs to be updated after every match. The following information will be stored in the system:

15
(CO3)
(PO2)

- Team name
- Team rank
- Total number of red cards
- Total number of yellow cards

Construct the information system using C program, having the following features:

- The system stores the information for all 32 countries.
- The system loads the previously written information from a file named "info.txt". You can assume a preloaded file is available with the team names and ranks. The red and yellow card counts are set to 0 initially.
- The system asks the user about the number of red and yellow cards of each team from the latest match and write the updated information back to the same file.

- b) Toffee is a streaming platform which is the official broadcaster of FIFA World Cup 2022 in Bangladesh. To create an account in toffee, users need to set their username and password. The password must meet some criteria to be a valid password. The criteria are provided below:
- The length of the password must be at least 10
 - The password must contain both uppercase and lowercase letter
 - The password must contain at least one number
 - The password cannot have the word "password" as a part of it

10
(CO3)
(PO2)

Your task is to construct a password validator function using C program that takes a string as a parameter representing a password provided by the user. The function returns 1, if the password is valid, otherwise it returns 0.

6. a) Write a C program that prints its own source code n number of times, where n is a command line argument passed to the main function.
[Hint: In C, the macro `__FILE__` holds the path to the current file.]
- b) The code snippet provided in the Figure 7 is an attempt to implement a library function. There are some mistakes in the implementation.

13
(CO2)
(PO2)
2+5
(CO2)
(PO1)

```
char* fl(char* a, char* b){
    char *begin = *a;
    while(*a)
        a++;
    while(*b)
        *a++ = *b++;
    *a = '\0';
    return begin;
}
```

Figure 7: Code snippet for question 6.b)

- Identify the library function was attempted to be implemented.
 - Convert the code by correcting the mistakes in the given code snippet. (Any unnecessary changes will cause penalty)
- c) Is it possible to design a user-defined function which takes a number as a parameter and returns both of its square and square root? If your answer is no, explain why. If your answer is yes, provide a solution.

5
(CO2)
(PO1)

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CSE 4107: Structured Programming I

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Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Explain why using an 'if statement' is preferable to a 'switch statement'. 6
(CO2)
(PO1)
- b) Assume that *x* and *y* are variables of float datatype and *z* is a variable of int datatype in a program. In that program the scanf function is called as follows: 6
(CO2)
(PO1)
`scanf("%f%d%f", &x, &z, &y);`
 If the user enters the following inputs:
 12.3 45.6 789
 Determine the values that will be stored in the *x*, *y*, and *z* variables with proper justification.
- c) The "Yay Festival" takes place on February 29 in leap years. In Gregorian calendar, each leap year has 366 days instead of 365, by extending February to 29 days rather than the common 28 days. These extra days occur in each year that is an integer multiple of 4 (except for years divisible by 100, but not by 400). 13
(CO3)
(PO2)
 Write a C program to assess whether or not a certain year is appropriate for staging the "Yay Festival".
2. a) Assume that *i* is an int variable and *f* is a float variable. Determine the type of the conditional expression (*i* > 0 ? *i* : *f*) with proper justification. 6
(CO2)
(PO1)
- b) An insurance company has devised the following rules to calculate the premium and insurance amount for an individual: 13
(CO3)
(PO2)
- If a person's health is excellent and the person is between 25 and 35 years of age and lives in a city and is a male, then the premium is \$4 per thousand and his insurance amount will be \$2,00,000.
 - If a person satisfies all the above conditions except that the gender is female, then the premium is \$3 per thousand and her insurance amount will be \$2,50,000.
 - If a person's health is poor and the person is between 25 and 35 years of age and lives in a village and is a male, then the premium is \$6 per thousand and his insurance will be \$10,000.
 - In all other cases the person is not insured.
- Write a C program to determine the insurance amount and the premium of a person given his demographic information (i.e., age, gender, location etc.).

- c) Explain why we should avoid writing statements as **indicated by the comment** in Figure 1:

```
int i = 0, N = 38;
int a[N], b[N];
while (i < N)
    a[i] = b[i++]; // Avoid this type of statement
```

6
(CO2)
(PO1)

Figure 1: Code Snippet for Question 2 (b)

3. a) Provide a concise explanation of the concept of signed and unsigned integer overflow. 3 + 3
(CO2)
(PO1)
- b) Explain the rules of arithmetic conversions (both implicit and explicit) with suitable examples. 3 + 3
(CO2)
(PO1)
- c) Show the output of the program in Figure 2 with brief justification: 13
(CO3)
(PO2)

```
#include<stdio.h>

int main(){
    int arr[] = {2, 4, 6, 8, 10, 1, 3, 5, 7, 9};
    int *p, *q, a, b, c, d, e, f, g, h;
    p = &arr[0];
    q = &arr[5];
    a = *p++;
    b = *q++;
    c = *++p;
    d = *++q;
    e = *(p + 1);
    f = *(q + 1);
    g = *p + 1;
    h = *q - 1;
    printf("%d %d\n", *p, *q);
    printf("%d %d %d\n%d %d %d\n%d %d", a, b, c, d, e);
    printf("%d %d %d", f, g, h);
    return 0;
}
```

Figure 2: Code Snippet for Question 3. c)

4. a) Consider the arithmetic sequence, $f(N) = 1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \dots + \frac{1}{N}$, where the value of N can range from 5 to 100 inclusive. 13
(CO3)
(PO2)
Write a C program to find the summation of the arithmetic sequence using **recursion**.
- b) Suppose you are given an array of size N , where $0 < N < 1000$, and a key value K , where $0 < K < 10000$. 6 + 6
(CO3)
(PO2)
Write a C program to perform the following:
- Find out whether the key value K is present in the array or not. If the key is present, then print "FOUND", otherwise print "NOT FOUND".
 - If the key is present, find out the index of the key and print it.
- You have to write separate functions to complete task (i) and (ii).

5. a) The upper triangular matrix has all the elements below the main diagonal as zero. For 13
 example, $\begin{bmatrix} 1 & 2 & 3 \\ 0 & 4 & 5 \\ 0 & 0 & 6 \end{bmatrix}$ can be considered as an upper triangular matrix. (CO3)
 (PO2)

Suppose you are given a matrix of size $n \times n$, where $0 < n < 10$. Write a C program to find out whether the matrix is an upper triangular matrix or not.

- b) Show the output of the program in Figure 3: 12
 (CO3)
 (PO2)

```
#include<stdio.h>

int main(){
  int x = 7;
  int y = 10;
  int z = 5;
  int result = 0;
  result = ++y - 10 || z - 5 && x++;
  result += y++ - 11 || z++ - 5 && x++;
  result += y + 1 > 11 && (z++ >= 6 || x++);
  printf("result: %d\n", result);
  printf("x: %d\n", x);
  printf("y: %d\n", y);
  printf("z: %d\n", z);
  return 0;
}
```

Figure 3: Code Snippet for Question 5 (b)

6. a) The FIFA world cup 2022 has officially started this month. Now, a lot of information needs 7 + 3
 to be recorded regarding the teams and players for future reference. As a football enthusiast + 3
 your friend asked you to take on the task to record everything. He has devised a way to (CO3)
 arrange the information like the following: (PO2)

The **TEAM** information consists of:

- Country
- Number of players (main team players + substitutes)
- Number of coaches (head coach + assistant coaches)
- Number of matches played
- Number of matches won
- Number of matches lost
- Position in the tournament (if the team cannot complete group stages, then it's position will be "groups" and so on)

The **PLAYER** information consists of:

- Name
- Position
- Number of matches played
- Number of passes made
- Number of goals scored
- Is he a main team player or a substitute

Based on the aforementioned information:

- i. Devise an efficient way to store the information of the teams and the players.
- ii. Write a function to find out how many matches have been drawn by a particular team.
- iii. Based on the goal's scored by an individual, write a function to get the player who scored the most goals.

- b) The "string.h" header file provides us with several built-in library functions. The `strlen()` function returns the length of a string passed to it. The `strcpy()` function copies one string to another. 12
(CO3)
(PO2)
Create your own `strlen()` and `strcpy()` functions in a C program and demonstrate the working principles of those two functions.

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DURATION: 3 HOURS

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MATH 4141: Geometry and Differential Calculus

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 6 (six)** questions. Marks of each question and the corresponding CO and PO are written in the right margin with brackets.

1. (a) Consider the function $f(x) = 3x^4 - 4x^3$, 6×2
- i. Find the intervals on which $f(x)$ is increasing. (CO1)
 - ii. Find the intervals on which $f(x)$ is decreasing. (PO1)
 - iii. Find the open intervals on which $f(x)$ is concave up.
 - iv. Find the interval on which $f(x)$ is concave down.
 - v. Find the critical points and inflection points, if any.
 - vi. Make a rough sketch of $f(x)$.
- (b) Evaluate the following limits (if possible) using a suitable method. 3×4
- i. $\lim_{x \rightarrow \infty} \frac{5x^3 + 3x^2 - 1}{4x^3 + 5x}$, (CO1)
 - ii. $\lim_{x \rightarrow -\infty} \frac{4x^2 - x}{2x^3 - 5}$, (PO1)
 - iii. $\lim_{x \rightarrow 0} \left(\frac{1}{x^2} - \frac{\cos 3x}{x^2} \right)$.
- (c) State Mean Value Theorem. Verify the theorem for the function $f(x) = x^3 + x - 4$ on the interval $[-1, 2]$. 3+6
- (CO2)
(PO1)
2. (a) i. State Intermediate Value Theorem. 3+5
- ii. Find the absolute maximum and minimum values of the function $f(x) = 2x^3 + 3x^2 - 12x$ on the interval $[-3, 2]$, and determine where these values occur. (CO1)
- (b) i. Write down the statement of Leibnitz's Theorem. 3+7+7
- ii. If $y = a \cos(\ln x) + b \sin(\ln x)$, then show that (CO2)
- $$x^2 y_{n+2} + (2n+1)xy_{n+1} + (n^2+1)y_n = 0.$$
- (PO1)
- iii. If $y = x^{2n}$, then show that $y_n = 2^n \{1.3.5 \dots (2n-1)\} x^n$, where $n \in N$
- (c) i. Use implicit differentiation technique to find $\frac{dy}{dx}$ for a Lemniscate represented 5+3
- $$\text{by } 2(x^2 + y^2)^2 = 25(x^2 - y^2).$$
- (CO2)
(PO1)

- ii. Find an equation for the tangent line to the Lemniscate (mentioned above) at the point (3,1).
3. (a) i. Define the continuity of a function. Is a differentiable function continuous? 4+5
 ii. Use derivative function to find an equation for the tangent line to the curve (CO1)
 $y = x^3 - 2x + 1$ at the point (0,1). (PO3)
- (b) Discuss the continuity and differentiability at $x = 0$ and $x = \frac{\pi}{2}$ of the following function 6×2
 (CO1)
 (PO1)
- $$f(x) = \begin{cases} 1; & x < 0 \\ 1 + \sin x; & 0 \leq x \leq \frac{\pi}{2} \\ 2 + \left(x - \left(\frac{\pi}{2}\right)\right)^2; & x \geq \frac{\pi}{2} \end{cases}$$
- (c) i. Find $f'(x)$ if $f(x) = \left(\frac{1}{x} + \frac{1}{x^2}\right)(3x^3 + 27)$. 4×3
 (CO1)
 (PO1)
- ii. Find $g'(x)$ if $g(x) = \frac{2x^2 + 5}{3x - 4}$.
- iii. Find $\frac{dy}{dx}$ if $y = (1 + x^5 \cot x)^{-8}$.
4. (a) i. Define what second derivative test is. 3+8+7
 ii. Find the relative extrema of the function $f(x) = 3x^5 - 5x^3$. (CO1)
 iii. Use Newton's method to approximate the real solutions of $x^3 - x - 1 = 0$. (PO1)
- (b) A baseball diamond is a square whose sides are 27 m long. Suppose that a player running from second base to third base has a speed of 9 m/s at the instant when he is 6 m from third base. At what rate is the player's distance from home plate changing at that instant? 7
 (CO4)
 (PO1)
- (c) i. Write the statement of Taylor's Theorem with Lagrange's form of remainder and Cauchy's form of remainder. 3+5
 (CO2)
 ii. Expand $e^{ax} \cos bx$ in finite Maclaurin's series with the remainder in Lagrange's form. (PO1)
5. (a) State and prove Euler's Theorem for a homogeneous function of two variables. Hence, 5×2
 verify Euler's Theorem for the function $u(x,y) = \frac{x(x^3 - y^3)}{x^3 + y^3}$. (CO1)
 (PO1)
- (b) i. Find the second-order partial derivatives of $f(x,y) = \sin(3x^2 + 6y^2)$. 4×2
 (CO1)
 ii. Let $w = (4x - 3y + 2z)^5$. Find $\frac{\partial^3 w}{\partial z \partial y \partial x}$. (PO1)
- (c) i. Define the radius of curvature of a curve. Find the radius of curvature at the 5+6+5
 point $\left(\frac{3a}{2}, \frac{3a}{2}\right)$ of the curve $x^3 + y^3 = 3axy$. (CO3)
 (PO1)
- ii. Name the properties that we need to check while tracing a curve. Using those properties, trace the Folium of Descartes curve: $x^3 + y^3 = 3axy$.

iii. Define what Envelope is. Find the envelope of the family of straight line $y = mx + \sqrt{a^2m^2 + b^2}$, where m is the parameter.

6. (a) Consider the second-degree equation: $8x^2 - 14xy + 6y^2 + 2x - y - 1 = 0$ 3×4
- i. Prove that the given equation represents a pair of straight lines. (CO1)
 - ii. Find their point of intersection, and the angle between the lines. (PO1)
 - iii. Hence, find the equation of the bisectors of the angles between them.
 - iv. Make a rough sketch of all the lines within a suitable reference axes system.
- (b) Find the projection of the joining of two points $(-1, -1, 3)$ and $(2, 0, 1)$ on the line through the points $(-7, 5, 3)$ and $(2, 6, 8)$. 6
- (c) i. Find the equation of the plane that passes through the points $(2, 2, 1)$ and $(9, 3, 6)$, and which is perpendicular to the plane $2x + 6y + 6z + 9 = 0$. 6+10
- ii. Find the equation of the plane through the intersection of the planes $x - 2y + z - 6 = 0$ and $2x + y - 2z - 3 = 0$, as well as through the point $(1, 2, 3)$. Also, find the equation of the plane through the intersection of the above-mentioned planes and perpendicular to the plane $3x + 4y - 3z - 5 = 0$. (CO3)
(PO1)

**ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)**

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

Phy 4141: Physics I

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (Six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

- | | | |
|-----------|--|----------------------|
| 1. | a) Discuss Niels Bohr's interpretation of a matter wave. Describe the wave behavior of an electron in an orbit around the hydrogen nucleus? | 7
(CO1)
(PO1) |
| | b) Define de Broglie wavelength. What are energy levels and spectra? Show the energy levels of hydrogen atom from the ground state up to the excited state. | 10
(CO2)
(PO1) |
| | c) An electron collides with a hydrogen atom in its ground state and excites it to a state of $n = 3$. How much energy was given to the hydrogen atom in this inelastic (kinetic energy is not conserved) collision? | 8
(CO2)
(PO1) |
| OR | | |
| | a) Discuss Bohr's correspondence principle. Name different quantum numbers. When quantum physics approaches the classical physics? | 7
(CO1)
(PO1) |
| | b) Obtain an expression for the orbital radii in Bohr atom. What is the condition for orbit stability? What happens when electrons change their orbits? | 10
(CO2)
(PO1) |
| | c) Find the wavelength of the spectral line that corresponds to a transition in hydrogen atom from $n = 6$ state to $n = 3$ state. Which part of the spectrum this transition refer to? | 8
(CO2)
(PO1) |
| 2. | a) Describe the five kinds of radioactive decay processes. Describe the nature of α , β , and γ radiation. What is half-life and mean life? | 7
(CO2)
(PO1) |
| | b) Show that the number N of undecayed nuclei at the time t is given by $N = N_0 e^{-\lambda t}$ where the symbols have their usual meaning. | 10
(CO2)
(PO1) |
| | c) The radionuclide ${}^{238}_{92}\text{U}$ decays into a lead isotope through the successive emissions of eight α -particles and six electrons. What is the symbol of the lead isotope? Calculate the total energy released. | 8
(CO2)
(PO1) |
| OR | | |
| | a) Discuss α , β , and γ decays with examples. Name some of the shielding materials for stopping the three radiations. What is the effect of magnetic field on the three types of radiation? | 7
(CO2)
(PO1) |
| | b) Showing all the intermediate decay processes describe the Uranium decay series from ${}^{238}\text{U}$ to ${}^{206}\text{Pb}$. What is inverse β -decay? | 10
(CO2)
(PO1) |
| | c) The atomic ratio between the Uranium isotopes ${}^{238}\text{U}$ and ${}^{234}\text{U}$ in a mineral sample is found to be 1.8×10^4 . The half-life of ${}^{238}\text{U}$ is $T_{1/2}({}^{238}\text{U}) = 2.5 \times 10^5$ years. Find the half-life of ${}^{238}\text{U}$. | 8
(CO2)
(PO1) |
| 3. | a) Define capacitance of a capacitor? Discuss how q , E , V and C of a capacitor change when a dielectric medium is inserted in a charged parallel plate air capacitor? | 7
(CO1)
(PO1) |
| | b) What are free and induced charge? Show that the induced charge is given by $q' = q(1 - 1/k)$, where the symbols have their usual meaning. Also show that $q' = 0$ when there is no dielectric medium in a capacitor. | 10
(CO2)
(PO1) |

- c) A 100 μF -farad capacitor is charged to a potential difference of 50 volts, the charging battery is then disconnected. The charged capacitor is then connected to a second capacitor. If the measured potential difference drops to 35 volts, find out the capacitance of the second capacitor. 8
(CO2)
(PO1)
- 4. a) Define current and resistance. Describe resistance from the atomic point of view. Write down the macroscopic and microscopic form of Ohm's law and explain the macroscopic and microscopic parameters. 7
(CO1)
(PO1)
- b) Define drift velocity and current density. Show that the drift velocity v_d is given by $v_d = j/ne$ where the symbols have their usual meaning. 10
(CO2)
(PO1)
- c) A rectangular carbon block has the dimensions $1.0\text{ cm} \times 1.0\text{ cm} \times 50\text{ cm}$. (i) find the resistance measured between the two square ends (ii) find the resistance between the two opposing rectangular faces (resistivity of carbon is $3.5 \times 10^{-5}\text{ Ohm-cm}$ at 20° C). Find the ratio of resistances for the two cases and give your reason for the ratio you got. 8
(CO2)
(PO1)
- 5. a) What is diffraction of light? Distinguish Fresnel and Fraunhofer diffraction. State the conditions for central maximum, the first minimum and the second minimum. 7
(CO1)
(PO1)
- b) For a single slit diffraction, obtain the expressions for the amplitude and the intensity. Show graphically how the relative intensity in a single-slit diffraction varies for different ratios of a/λ where the symbols have their usual meaning. 10
(CO2)
(PO1)
- c) In a single slit diffraction pattern the distance between the first minimum on the right and the first minimum on the left is 5.2 mm, The screen on which the pattern is displayed is 80 cm from the slit and the wavelength is 5460 A. Calculate the slit width ($1\text{ A} = 10^{-10}\text{ m}$) 8
(CO2)
(PO1)
- 6. a) Discuss polarization of light. With the help of a diagram describe an instantaneous snapshot of a plane polarized wave showing the electric and magnetic vectors. 7
(CO1)
(PO1)
- b) Describe the phenomenon of circular polarization. Describe how two-plane polarized waves of equal amplitude and at right angles to each other propagate along the z-axis. Derive an expression for the resulting intensity. 10
(CO2)
(PO1)
- c) A beam of circularly polarized light $E_x = E_m \sin \omega t$ and $E_y = E_m \cos \omega t$ falls on a polarizing sheet. Describe the emerging beam. 8
(CO2)
(PO1)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
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Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

CSE 4173: Introduction to Database Management System

Programmable calculators are not allowed. Do not write anything on the question paper. Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Describe the major drawbacks of using file systems to store data? 15
(CO1)
(PO1)
- b) Define super key and candidate key with suitable example. 5
(CO1)
(PO1)
2. a) Describe the following basic operators of relational algebra with suitable example: 3 × 5
(CO1)
(PO1)
- select σ
 - project Π
 - Cartesian product \times
 - rename ρ
- b) Explain the basic difference between inner join and outer join with suitable example. 5
(CO1)
(PO1)
3. a) There is a danger of using *natural join* construct in SQL. Briefly explain it using example. 5
(CO1)
(PO1)
- b) Differentiate between anonymous and named blocks in PL/SQL. "A function in PL/SQL can return more than one value." Justify it using suitable example. 5 + 5
(CO1)
(PO1)
- c) Explain the concept of total and partial participation in E-R diagram. Consider a one-to-many mapping cardinality between entities E_1 and E_2 . In implementation phase, is it possible to ensure total participation for both E_1 and E_2 using any table-level constraint? Justify your position. 10
(CO2)
(PO3)
4. a) Consider the following system description: 5 + 10
(CO3)
(PO2)
- In IUT students are enrolled against a particular department. The Student Information System (SIS) maintains students basic information such as ID, Name and CGPA. Department name, its location are the the relevant information for each department. Courses are offered in each semester. Each course has its code, title and credit hour. Multiple courses are taken by each student. Again one course can be taken by a group of students. The university runs a central board of different societies such as debate, photography and so on. For each society, SIS maintains the name and detailed description of the society. Each student must be attached to exactly one society.
- Design the system using standard the E-R Diagram and write the DDL statements to implement it.

Table 1: STUDENTS (Data for Question No. 4 b)

ID	Name	CGPA	Dept
1	a	3.5	CSE
2	b	3.7	EEE
3	a	3.5	CSE

b) Consider the following records of STUDENTS Table: 10
 Your task is to split the table into two for both (i) lossless and (ii) lossy decomposition. (CO1)

5. a) Define functional dependency. What is the basic motivation of using functional dependency in database design? Present example of each type of the following functional dependencies: 2 + 8
 i. trivial ii. non-trivial iii. semi-trivial iv. transitive (CO1)
(PO1)

b) Briefly mention primary rules of Armstrong's Axioms. Why are they called complete and sound? 5 + 5
(CO1)

c) Is 2NF stricter than 3NF? Briefly explain. Consider the following records of CITIZENS table: 2 + 8
 (Note: the last 3 attributes are namely districts name,size and population) (CO1)

Table 2: CITIZENS (Data for Question No. 5. c)

ID	Name	DistName	DistSize	DistPolulation(in million)
101	a	Dhaka	Large	20.5
102	b	Rajshahi	Medium	10.2
103	c	Dhaka	Large	20.5
104	a	Khulna	Medium	8.9
105	f	Rajshahi	Medium	10.2

Your task is to verify if the relation is in 3NF. You need to deduce functional dependencies from the given data set. If this is not in 3NF then suggest a loss-less decomposition. (Hint: You do not need to check 2NF condition, just check if it exhibits transitivity dependency for non prime attributes)

6. a) Briefly explain why the closure of attributes and concept of superkey are closely linked. Consider the following relation R and functional dependencies (FDs): 10
 $R(A, B, C, D)$ given FDs: $AD \rightarrow BC$ $B \rightarrow D$ $C \rightarrow A$ (CO1)
 Show all steps to determine all possible candidate keys for the above relation. (PO1)

b) Consider the following relation R and functional dependencies (FDs): 10
 $R(A, B, C, D, E)$ given FDs: $A \rightarrow C$ $C \rightarrow E$ $B \rightarrow D$ $E \rightarrow A$ (CO3)
 Show each step to verify if the given relation is in BCNF. (PO2)

c) Briefly present a comparative analysis of sparse and dense indexing. Consider the following citizen relation: 5 + 5
 $CITIZEN(ID, Name, BloodGroup, YearlyIncome)$ (CO2)
 Here YearlyIncome indicates the exact yearly income of a citizen. Is it wise to apply bit-map indexing on YearlyIncome directly? Justify your position. (PO2)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
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DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

CSE 4175: Computer Programming

Programmable calculators are not allowed. Do not write anything on the question paper.
Answer all 6 (six) questions. Marks of each question are written in the right margin.

- 1. a) A string is called a palindrome if it reads the same backwards as forwards. Write a program that takes a string as input from the user and checks whether it a palindrome or not. Two samples are given below: 7

Enter a string: kayak This is a palindrome	Enter a string: program This is not a palindrome
---	---

Figure 1: Sample Input and Output for Question 1.a)

- b) Determine the output of the program given in Figure 2. 8

```
#include<stdio.h>
int f1(int);
void f2(int, int);
int main()
{
    int a=10, b=5;
    printf("%d %d\n", a, b);
    f2(a, b);
    printf("%d %d", a, b);
    return 0;
}
void f2(int a, int b)
{
    int i,j=10;
    for(i = 0; i < 5; i++)
    {
        j += f1(i);
    }
    a = i;
    b = j;
    printf("%d %d\n", a, b);
}
int f1(int i)
{
    return i+1;
}
```

Figure 2: Code Snippet for Question 1.b)

- c) The following two arrays are given which are already sorted in ascending order: 10
int A[10] = {2, 3, 3, 4, 5, 7, 9, 9, 12, 13};
int B[10] = {5, 5, 6, 8, 8, 9, 10, 12, 15, 17};
Write a program that creates a new array C[20] which will contain the elements of both A and B in ascending order.

- 2. a) Write a program that sorts the following list in descending order. 10
`int list[10] = {3, 12, 5, 2, 7, 9, 3, 12, 4, 9}`
- b) Write a program where the main function takes a character as input and print whether the input is an upper-case letter, lower-case letter, or a number. You must write three separate functions to perform the three different checks. You cannot check the type of the character in the main function. 8
- c) Write a program that takes two 3x3 matrices as input. All the elements in both matrices will be integers. The program will then print the sum of the two matrices. 7
- 3. a) A diagonal matrix is a matrix in which the entries outside the main diagonal are zeros. Write a program that takes a 5x5 matrix as input and checks if the matrix is a diagonal matrix. 9
- b) Write a program that takes a number, *n*, as input from the user and draw a pattern similar to Figure 3. 8

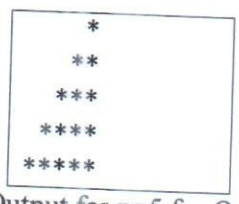


Figure 3: Output for n=5 for Question 3.b)

- c) Take a string as input that only contains alphabets. Convert the characters of the string to uppercase letters, and print it. 8
- 4. a) What is the output of the following code? Explain why this code works even though an integer value is being stored in a character variable. 8

```

#include<stdio.h>
int main()
{
    char ch;
    ch = 65;
    printf("%c %d", ch, ch);
    return 0;
}

```

Figure 4: Code Snippet for Question 4.a)

- b) The following code was written to find the average of five numbers accurate up to 2 digits after the decimal point. However, the code does not work due to five different errors. Identify the errors made in the code. 10

```

#include<stdio.h>
double getAvg(int)
int main(){
    int numbers[] = {13, 88, 675, 48, 22};
    double avg;
    avg = getAvg(numbers);
    printf("%f", avg);
    return 0;
}
int getAvg(int numbers){
    int i, sum;
    for(i=1; i < 5; i++){
        sum += numbers[i];
    }
    return sum/i;
}

```

Figure 5: Code Snippet for Question 4.b)

- c) Discuss how storing a string varies from all other types of arrays in C. 7

- 5. a) What is computer programming? Discuss the steps involved in solving a programming problem. 13
- b) A company has hired you to encrypt all their documents. You will be given strings with a maximum length of 100 characters. You must encrypt each character of the string according to the following rules: 12
 - If the character is an uppercase letter, then you could convert it to lowercase and take the immediate next character. For example, if the character is 'C', it will be converted to 'd'. Special case: If the character is 'Z', it will be converted to 'a'.
 - If the character is a lowercase letter, then you must convert it to uppercase and take the immediate previous character. For example, if the character is 'c', it will be converted to 'B'. Special case: If the character is 'a', it will be converted to 'Z'.
 - If the character is a number, you must convert it to '0'.
 - All other characters will remain unchanged.Now, write a program that takes a string input and encrypts it according to the given rules.

- 6 a) Using suitable examples, differentiate between pass by value and pass by reference when calling functions. 10
- b) Write a program that takes an integer as input from the user and prints the sum of all the digits of the integer. 9
- c) If $a = 10, b = 12, c = 0$, determine whether the following expressions will be true or false: 6
 - i. $a != 6 \ \&\& \ b > 5$
 - ii. $!(a > 5 \ \&\& \ c)$
 - iii. $5 \ \&\& \ c != 8 \ || \ !c$

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SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

CSE 4301: Object Oriented Programming

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

- 1. a) Write short notes on the following topics: 3 × 5
 - i. Function overloading (CO1)
 - ii. Virtual Base Class (PO1)
 - iii. Virtual Function
 - iv. Abstract Class
 - v. Forward Declaration
- b) Discuss the process of making an executable file for a multi-file c++ application. Discuss the difference between declaration and definition of variable, function, and class. In a multi-file application, explain the usage of declaration and definition. 10
 - (CO1)
 - (PO1)
- 2. In a cellular network system in figure 1, there are Base Transceiver Station (BTS) and Cellular devices (C). Multiple C objects registered under one BTS. A cellular object does not communicate directly to other cellular objects. It communicates via a BTS. The sending cellular object sends data to its registered BTS (Uplink Communication). Then that BTS will send the data to the BTS where the receiver cellular object is registered to. After that, the receiver cellular object receives data from the BTS (Downlink Communication). 30
 - (CO4)
 - (PO3)

Each BTS contains multiple Resource Block (RB) objects for both uplink and downlink cellular communication. Uplink and Downlink resources are different. Assume that BTS assigns one uplink and one downlink RB object to each registered C when it starts any cellular communication. After communication ends, BTS yields back the resources so that it might be used by another C starting cellular communication. It should be noted that a C object registered under one BTS does not mean that C has started cellular communication.

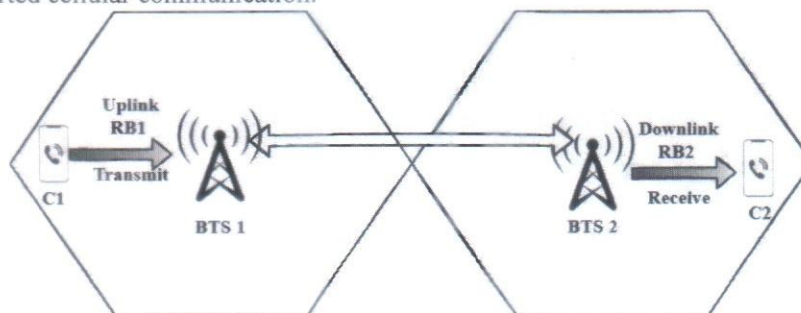


Figure 1: Cellular Communication

Write an OOP program where you can simulate the above scenario. To do so you will need class definitions of BTS, C, and RB. Use STL container instead of fixed size array where it is applicable. In the following table, some noteworthy attributes and behaviors are mentioned. You must incorporate these attributes and behaviors. You may need to add functions other than these. You are not required to write down the main() function.

You need to write exception classes also to throw specific exceptions. In the following table 1, scenarios are mentioned where the exceptions should be raised.

Table 1: Attributes, behavior and exception for Question 2

Class Name	Attributes	Behavior	Exception
BTS	2D Coordinate, uniqueID	allocateRBCell(RB*,C*) deallocateRBCell(RB*,C*) getFreeRBs() - return a vector of free RBs under that BTS	1. Trying to allocate already allocated RBs. 2. Trying to allocate another RB to a Cellular Device which is already using RB. 3. A cellular device want to start the communication but no free RBs are present
C	2D Coordinate, currentTransmissionPower, minTransmissionPower, maxTransmissionPower, uniqueID	startCommunication() endCommunication() status() - this function will print the uniqueID of C. If it is under cellular communication then it shows the uniqueID of RBs of uplink and downlink.	
RB	currentTransmissionPower, minTransmissionPower, maxTransmissionPower, isUplinkRB, channelFrequency, uniqueID	status() - this function will print the uniqueID of RB. If downlink RB then print minTransmissionPower, maxTransmissionPower	

3. CourseResult class is responsible for storing the result of a student for an individual course. It stores the information of Course Code, Course Title, Credit, Grade Point (result of the student), and Semester. Student class is responsible for storing the information of a student. It stores the information on student name and student ID. Moreover, a student can register for multiple courses. Write necessary class definition for this scenario. 30 (CO4) (PO3)

Write a function `generateSemesterWiseResult()`, which will print the result of a student. In the printed result, grades of each semester will be shown in ascending order of semester number. In the result of each semester, Grade Points in each course of that semester will be shown followed by Grade Point Average of that semester, and Cumulative CGPA earned at the end of that semester.

ResultService class is responsible for the result of all students. Create a member function `sortStudents()`, which sorts the Student class objects according to CGPA.

You need to include the file read and write operations of student class, so that the information is not erased when the program is closed. When the program restarts it should load the data from the file.

4. a) Consider Code Snippet in figure 2. Now overload `<<` operator to set salary for an employee. Also overload `>>` operator to get the salary for an Employee. 10 (CO2) (PO2)

```
#include <iostream>
using namespace std;

class Employee{
    int salary, bonus;
public:
    Employee(int _salary):salary(_salary),bonus(salary*10/100){}
    Employee(int _salary, _bonus):salary(_salary),bonus(salary*_bonus/10){}
};
```

Figure 2: Code Snippet for Question 4. a)

b) Assume that you create a class by deriving from a base class which contains only a parameterized constructor. Do you need to write a constructor in the derived class? Give reasons to support your answer with example code. 5 (CO1) (PO1)

5. a) You want to simulate the application of heat on different substances at different states of matter. The amount of heat that is required to increase the temperature of unit mass of that substance at some state by one degree is known as specific heat of that substance at that state. The temperature at which a substance's state changes from solid to liquid or vice-versa is known as melting point. On the other hand, the temperature at which a substance's state changes from liquid to gaseous or vice-versa is known as boiling point. At melting point or boiling point if you apply heat that energy is used to change the state of the substance instead of changing the temperature of the substance. The heat absorbed by a unit mass of a given solid at its melting point that completely converts the solid to a liquid at the same temperature is known as heat of fusion. The heat absorbed by a unit mass of a given liquid at its boiling point that completely converts the liquid to a gaseous state at the same temperature is known as heat of vaporization. 13 (CO2) (PO2)

If you apply heat to a solid state of a substance based on the specific heat and mass of the substance the temperature will continuously rise to melting point. Then it would take heat of fusion to convert from unit mass of solid to liquid state and there will be no change in temperature. After that, if you apply heat to a liquid state of a substance based on the specific heat of the liquid and mass of the substance, the temperature will continuously rise to boiling point. Similarly, it would take heat of vaporization to convert from unit mass of liquid to gaseous state and there will be no change in temperature.

Now create a substance class which follows the above-mentioned rules for application of heat. Sample public member functions of the class can be:

- getTemperature() returns the current temperature of the substance
- getState() returns the current state of the substance
- applyHeat(double amount) and removeHeat(double amount) change the temperature and the state of the substance accordingly

It should be noted that some of the attributes are constant which implies that it cannot be changed once you initialized. Use const modifier for those attributes.

b) You created a class substance in question 5. a). Now assume that you want to simulate the mixing of two substance objects. It should be noted that heat transfers from high temperature to low temperature. Write a function and place it in a suitable place to simulate this behavior. 7 (CO2) (PO2)

c) Why do programmers opt for a new mechanism (known as "exception") to handle error instead of using simple if else block. 5 (CO1) (PO1)

- 6. a) Complete the definition of the classes according to the instructions given as comments in Figure 3. You cannot use any library other than iostream. The output of the given main() is (A: 2), (B: 1).

20
(CO3)
(PO2)

```

#include <iostream>
using namespace std;

class element{
    char key;
    int count;
public:
    /*Implement appropriate constructors, getter and setters*/
};
class dictionary{
    /*Declare an object pointer of 'element' class and other
properties as necessary*/
public:
    /*Create necessary constructors*/
    /*Check if element with the given key exists*/
    bool hasElement(char key);
    /*Add a new element to the array of 'element' objects. Return false
if element already exists. Else return true.*/
    bool addElement(element elm);
    /*Add a new element to the array of 'element' objects initialized
key, count. Return false if element already exists. Else return true.*/
    bool addElement(char key, int count);
    /*Remove element from array of 'element' objects. Return false if no
such element exists. Else return true.*/
    bool removeElement(element elm);
    /*Remove element from array of 'element' objects by matching the
key. Return false if no such element exists. Else return true.*/
    bool removeElement(char key);
    /*Increase count of the element that matches the key. Return false
if no such element exists. Else return true.*/
    bool increaseCount(char key);
    /*Decrease count of the element that matches the key. Return false
if no such element exists. Else return true. If element's count
decreases to zero, remove the particular element*/
    bool decreaseCount(char key);
    /*Print all existing elements along with their count.*/
    void printElements();
};
int main()
{
    char addingList[] = "ABACB";
    char deleteList[] = "BCCGG";
    dictionary dict;
    for(int i=0;i<5;i++){
        if(!dict.addElement(addingList[i],1))
            dict.increaseCount(addingList[i]);
    }
    for(int i=0;i<5;i++){
        dict.decreaseCount(deleteList[i]);
    }
    dict.printElements();
}

```

Figure 3: Code Snippet for Question 6. a)

- b) Explain the role of iterator as an STL entity.

5
(CO1)
(PO1)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

SWE 4301: Object Oriented Concepts II

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

- 1. a) "A good design should exhibit high cohesion and low coupling."-Justify the assertion by considering two principles of SOLID. 8
(CO1)
(PO1)
- b) Draw a diagram to illustrate how SOLID principles are related with each other. 10
(CO1)
(PO1)
- c) "Violation of Liskov Substitution Principle (LSP) is a latent violation of Open Close Principle (OCP)."- Explain the statement with an example. 7
(CO1)
(PO1)
- 2. a) Figure 1 represents a program as a graph. The nodes represent type/class, the filled edges represent program flow direction and the dashed edges represent source code dependency direction. This program does not follow Dependency Inversion Principle (DIP). 7
(CO4)
(PO1)

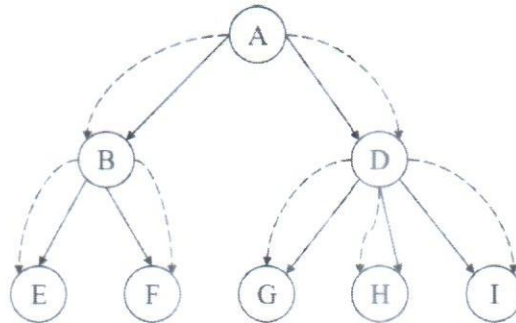


Figure 1: Dependency graph of a program

With a brief explanation, redraw the graph considering the program follows DIP.

- b) In a software development team, one of the developers encouraged others to perform refactoring by saying that "Critical bug will be fixed as a result of refactoring." 5+5
(CO1)
(PO1)
 - i. Explain why the statement above incorrectly uses the term refactoring.
 - ii. Based on the definition of refactoring, explain how unit testing is related to it.
- c) Briefly explain each of the following code smells with example: 4 x 2
(CO1)
(PO1)
 - i. Refused Bequest
 - ii. Middle Man
- 3. a) How is encapsulation different from Information hiding? Justify your answer. 6
(CO1)
(PO1)
- b) What is clean code? Write four practices to ensure clean code. 5
(CO1)
(PO1)
- c) Briefly describe Retention Policy of custom Annotation. 5
(CO1)
(PO1)



d) The SimpleQueue class in Figure 2 presents a queue implementation.

5+4
(CO3)
(PO1)

```

1 class SimpleQueue {
2     Queue<Integer> queue;
3     SimpleQueue() {
4         this.queue = new LinkedList<>();
5     }
6     void enqueue(Integer val){
7         this.queue.add(val);
8     }
9     Integer dequeue(){
10        Integer value = this.queue.remove();
11        return value;
12    }
13 }

```

Figure 2: Code Snippet for Question 3.d)

- i. Figure 2 only supports Integer data type. Write a generic version of this class so that any type of Comparable object can be supported.
 - ii. Write two advantages and disadvantages of Generics.
4. a) AmazeSoft wants to build a program that can generate tickets for different vehicles like buses, airplanes with traveller information, for example, name, age, and gender. The program can also print a full-color or grayscale ticket. A ticket has other details like fare price, source, destination, departure time, arrival time, and traveller information. Figure 3 represents the initial code to fulfill those requirements. Traveller, and Ticket are user-defined classes, and other methods are implemented as well. You can assume that the code has no compile time error.

```

1 class TicketGeneratorAndPrinter {
2     // remember to reset these flags to change vehicle and
3     // color printing
4     int vflag = 1;
5     boolean cprint = true;
6
7     void generateTicket(Traveller traveller){
8         Ticket ticket;
9         if(vflag==1) ticket = busTicket(traveller);
10        else ticket = airTicket(traveller);
11    }
12
13    void printTicket(Ticket ticket){
14        if(cprint) fullcolorPrint(ticket);
15        else grayscalePrint(ticket);
16    }

```

Figure 3: Code for Question 4.a)

- i. Figure 3 has several design smells. With a brief explanation, identify at least 4 design smells. Mention the line numbers.
- ii. Rewrite the code satisfying SOLID principles to remove design smells. You can use Class Diagram or any preferred Object Oriented Programming language.

8
(CO4)
(PO1)
12
(CO4)
(PO2)

iii. Write a lambda expression that will print all tickets which has the same destination address.

5
(CO3)
(PO1)

5. a) The code snippet in Figure 4 contains code smells.

```

1 public class Account {
2     String type;
3     String accountNumber;
4     private int amount;
5
6     public void debit(int debit) throws Exception{
7         if(amount <= 500)
8             throw new Exception("Minimum must be > 500");
9         amount = amount-debit;
10        System.out.println("Now amount is " + amount);
11    }
12
13    public void transfer(Account from, Account to, int
14        creditAmount) throws Exception{
15        if(from.amount <= 500)
16            throw new Exception("Minimum must be > 500");
17        to.amount = amount+creditAmount;
18    }

```

Figure 4: Code Snippet for Question 5. a)

i. Identify two code smells and rewrite the code after refactoring.

6
(CO4)
(PO1)

ii. Using Reflection, write a method that will check whether the amount field is private or not.

5
(CO3)
(PO1)

iii. Write a custom exception named as BalanceException and rewrite the debit method to throw BalanceException instead of Exception.

6
(CO3)
(PO1)

iv. Write a test case that will validate minimum amount for transfer method.

3
(CO2)
(PO1)

b) Differentiate Mutable and Immutable Object with an example.

5
(CO1)
(PO3)

6. a) Describe the use of the final keyword. Write the difference between two declarations in Figure 5.

5
(CO1)
(PO1)

```

1 final double pi = 3.1416;
2 final Account[] accounts = new Account[5];

```

Figure 5: Code Snippet for Question 6.a)

b) How are accessors and mutators related with pure and impure functions?

5
(CO1)
(PO1)

- c) What is Mutual Exclusion? How can mutual exclusion be achieved in Java? 5
(CO1)
(PO1)
- d) Demonstrate Producer/Consumer Relationship in Multi-Threading without synchronization by using your preferred programming language. 10
(CO1)
(PO1)

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4303: Data Structures

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) With proper justification, determine whether the following sequences can represent the preorder traversal of any valid Binary Search Tree (BST). Reconstruct the original BST if valid.

	16
	(CO3)
i. 40, 30, 39, 45, 43, 102, 100, 230.	(PO2)
ii. 10, 9, 5, 7, 8, 110, 100, 95, 103, 111.	
iii. 10, 15, 20, 25, 24, 21, 23, 30, 35, 33.	
iv. 40, 30, 35, 20, 80, 100, 110, 120.	

- b) i. Argue on storing a binary tree using array-based vs pointer-based approach. 4+5
 ii. A perfect binary tree has 2^k nodes at depth k for $k = 0, 1, \dots, h$. Use this to prove that a perfect binary tree of height h has $2^{h+1} - 1$ nodes. (CO3)
(PO2)

2. a) Showing details steps, insert the following numbers in a Red Black tree.
 8, 18, 5, 15, 17 10
(CO4)
(PO3)

- b) If P is a node in a Red Black tree that has exactly one child, then argue on the following statements. 10
(CO3)
(PO4)
 - i. The one child must be red.
 - ii. The one child must be a leaf node.
 - iii. The node P must be black.

3. a) Each cell (i, j) in a sparse table stores the result of a particular function for the range $[j, j + 2^i)$ over an array, where i denotes the value of the row and j denotes the value of the column. Table 1 represents a sparse table for storing the maximum value over a range in an array A and Table 2 represents a sparse table for storing the minimum value over a range in array A . The first row of both the table is omitted. Reconstruct the original array A from these two partial sparse tables. 13
(CO4)
(PO3)

Table 1: Sparse Table for storing Maximum Value

10	11	11	9	9	15	15	–
11	11	11	15	15	–	–	–
–	–	–	–	–	–	–	–

Table 2: Sparse Table for storing Minimum Value

5	5	8	8	2	2	15	–
5	5	2	2	2	–	–	–
–	–	–	–	–	–	–	–

- b) $A = [10, 5, 18, 14, 35, 32, 16, 4]$ 6 + 6
- i. Create a segment tree that can answer the GCD of any given range between 1 to 8 (maintaining 1-indexing notation) of the given array A. (CO4)
(PO2)
 - ii. From the segment tree find out the GCD of the following range and make a list of the exact nodes of the tree that contributes to the GCD value.
 - 1) [1:3]
 - 2) [3:4]
 - 3) [4:7]

4. Consider the following person database and hash function:

Table 3: Person Database

Name	Age	Sex
Ross	32	Male
Chandler	36	Male
Monica	30	Female

```

int hash_function(person P)
{
    string name = P.name;
    int age = P.age;
    int sex = P.sex;
    int mod = 18;
    int hash = name.size();

    if(sex == "Female") hash++;
    for(int i = 0; i < name.size(); i++){
        int ascii_val = (int)name[i];
        hash += ascii_val - 97;
    }
    return hash % mod;
}

```

Figure 1: Hash function

- a) Calculate the hash values using the given hash function for all the entries in the person database. 5
(CO1)
(PO1)
 - b) Create two additional non duplicate entries in the database with age less than 40, for which the calculated hash value using the given hash function will collide with at least one of the existing entries' hash values. 10
(CO4)
(PO3)
 - c) With proper justification, propose two modifications in the given hash function that will lessen the probability of collision between multiple entries. 10
(CO4)
(PO3)
- 5
- a) You are given a set of strings A. Propose a prefix tree-based algorithm to find the longest common prefix of all strings of set A. 8
(CO4)
(PO2)
 - b) You are given the following integer array A. 7+10
(CO4)
 $A = [4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15]$
 - i. Create a Prefix Tree by inserting the equivalent k bit binary representation of each of the elements of the array A by maintaining the following constraints: (PO2)
 - k = 6 [add leading zeros if necessary]
 - Bits should be inserted in order of significance i.e., the most significant bit should be inserted first and the least significant bit should be inserted last.

- ii. Propose an algorithm to find $\max_{(y \in A)}(x \oplus y)$. The algorithm should iterate the tree from the root node to any leaf node once and have a time complexity of $O(k)$.

- 6 a) Demonstrate the step-by-step process to sort the following set of numbers in descending order using the Heap Sort algorithm: {22, 55, 36, 109, 45, 12, 63, 71, 52, 97, -10} 11
(CO1)
(PO1)
- b) Argue on Red Black Tree vs AVL Tree from the perspective of time complexity. 7
(CO3)
(PO1)
- c) Argue on Segment Tree vs Sparse Table from the perspective of space and time complexity while performing range queries. 7
(CO3)
(PO1)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4305: Computer Organization and Architecture

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) It is a common practice to use a symbolic representation of machine instructions to write a machine-language program. Consider the following high-level language instruction: 2+2+3+8
(CO2)
(PO1)

$$X = \frac{(A + B \times C)}{D - E \times F} \times (G + \frac{H}{I})$$

- i. What are the common sources of these operands?
 - ii. What are the basic elements of a machine instruction?
 - iii. Draw an instruction cycle state diagram showing all the steps involved in instruction execution
 - iv. Write two separate programs using two- and one-address machine instruction formats respectively to compute the above expression. Values of given operands should not be changed during execution.
- b) A *procedure* is the most significant invention in the evolution of programming languages. It is an independent computer program that is embedded within a bigger program. The procedure may be invoked or called at any time within the program. An example program where procedures are called multiple times during its execution is illustrated in Figure 1. 5+5
(CO3)
(PO2)

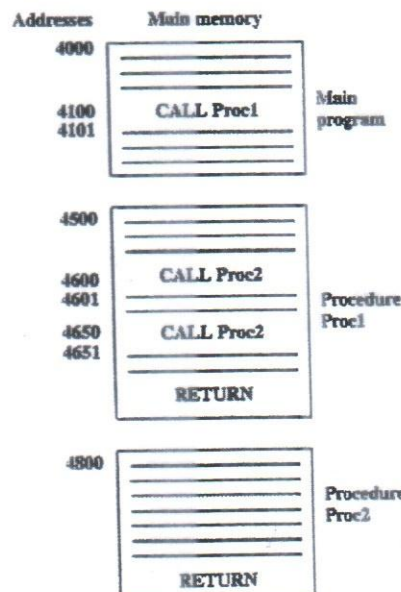


Figure 1: A program with *procedure calls*.

- i. Draw an execution sequence diagram illustrating how the procedures are called at different addresses during program execution.
- ii. Based on the given scenario, demonstrate how a processor employs a stack data structure to store return addresses and implement nested procedure calls.

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2. In a uniprogramming system, the main memory is divided into two sections: one for the operating system and one for the currently executing program. The later section of this multiprogramming system's memory is partitioned to accommodate multiple processes. Suppose a process references five pages, A, B, C, D, and E, and the following sequence of virtual page numbers is observed on a computer with virtual memory:

A; B; C; D; A; B; E; A; B; C; D; E

- a) What is process? Why is its state considered important in multiprogramming? Draw a figure illustrating the life cycle of a process. 5 (CO3) (PO2)
 - b) Why would the main memory of a multiprogramming system such as the preceding example be expanded hypothetically? Discuss briefly the common methods utilized by operating systems to increase main memory with required figures. 10 (CO3) (PO2)
 - c) Employ each replacement algorithm to compute the total number of page transfers during this sequence of references, beginning with an empty main memory that contains four-page frames. Demonstrate the intermediate phases of the calculation, taking into account any necessary assumptions. 10 (CO3) (PO2)
3. a) In a typical instruction style, the address field(s) are quite small. However, we prefer to access a large number of locations in main memory or virtual memory. Various addressing strategies have been utilized to achieve this objective. 2+5+5+8 (CO2) (PO1)
- i. How does the processor determine the addressing mode of an instruction's operand(s)?
 - ii. In displacement addressing mode, how does the CPU calculate the effective address (EA)? Which variations does this mode entail? Introduce them briefly.
 - iii. Compare post- and pre-indexing addressing mode with the relevant figures.
 - iv. If an instruction's address field contains the decimal value 14, determine the EA of the corresponding operand for all conceivable basic addressing modes. Assume a mandatory variable in any field that requires one and also discuss any anomalies, if any.
- b) Various techniques can be used to predict whether a branch will be taken or not. Among them dynamic branch prediction approaches depend on the execution history. Briefly explain those approaches with appropriate figures. 5 (CO5) (PO1)
4. a) The ALU of a computer system can add two input registers and logically complement the bits of either register, but it doesn't have any built-in logic to perform subtraction. The integers must be stored in twos complement format in those registers. Assume R1 and R2 are the addresses of those registers. 4+5+5+6 (CO5) (PO1)
- i. Write a program of machine instructions to perform subtraction operation between these two registers.
 - ii. Draw the data flow diagram (*i.e.*, a sequence of events) to perform the same subtraction operation.
 - iii. Make a list the micro-operations that the associated control unit must do in order to reformulate the event sequence you have previously generated.
 - iv. If the registers contain 11110000 and 0010100 respectively what would be the value of the following flags: Carry, Zero, Overflow, Sign, Even Parity, Half-Carry
- b) Explain "cycle stealing" with necessary figure. 5 (CO6) (PO1)

5. a) To the concept of instruction execution, we must recognize that, in fact, an instruction has a number of stages. Such a pipelined processor has a clock rate of 2.5 GHz and executes a program with 1.5 million instructions. The pipeline has six stages, and instructions are issued at a rate of one per clock cycle. 4+3+3+5
(CO5)
(PO1)

- i. Draw a flow chart of six stage “CPU instruction pipeline” depicting the logics necessary for branches and interrupts
- ii. Ignoring penalties due to branch instructions and out-of-sequence executions what is the speedup of this processor for this program compared to a nonpipelined processor? Show the intermediate calculating steps.
- iii. What is the pipelined processor's throughput (in MIPS) with the same assumptions?
- iv. What is pipeline bubble? Provide some instances demonstrating how this event can occur in a variety of ways under the aforementioned circumstances, along with the required figures.

b) Assume a disk drive comprises of four drives with a 200 GB capacity each. 4+6

- i. Draw a diagram illustrating the mapping between logical and physical disk space for such disk drive. (CO4)
(PO1)
- ii. What is the available data storage capacity for each of the RAID levels 0, 1, 3, 4, 5, and 6?

6. a) The issue with programmed I/O is that the CPU must wait a considerable amount of time for the I/O module in question to be prepared for data receiving or transmission. A different method for the processor to accept interrupts from I/O modules in order to complete such data communications. 2+6+6+6
(CO6)
(PO1)

- i. What role does the I/O module play in this strategy?
- ii. The occurrence of an interrupt initiates a series of hardware and software processor activities. With an appropriate flow diagram explain how such interrupt is processed to complete an I/O operation in this way.
- iii. Implementing Interrupt-driven I/O entailed a number of design issues. Discuss these concerns and their variants briefly.
- iv. What is *interrupt controller*? Draw a diagram of a computer system illustrating how I/O devices can be connected to a processor using interrupt controller(s).

b) The DMA mechanism can be configured in numerous ways to regulate bus access. Design some potential configurations for this aspect. 5
(CO6)
(PO1)

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
 DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
 FULL MARKS: 150

CSE 4307: Introduction to Database Management System

Programmable calculators are not allowed. Do not write anything on the question paper. Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

-
1. a) Differentiate between relation and relation instance. "A relation may not have any superkey" - briefly mention when this situation may occur and state the associated problem. 5
(CO1)
(PO1)
- b) Suppose you are going to automate a typical private company's human resource management system. How will you select the format of employees ID? Explain briefly. 5
(CO2)
(PO3)
- c) Suppose R and S are two relations. In order to concatenate them (i.e. UNION operation) two conditions must be met. Briefly mention them. "Even these two conditions are satisfied the result of concatenation could be erroneous" - justify this fact with example. 10
(CO1)
(PO1)
2. a) Consider the following SQL with the assumption that mentioned table exists: 5
(CO1)
(PO1)
- ```
select id,name,dept
from students
where dept='CSE';
```
- Your task is to write two equivalent queries of the above SQL statement using relational algebra.
- b) Consider the following entities ( $pk$  denotes primary key while  $fk[x]$  implies foreign key referencing entity  $x$ ): 5 × 3  
(CO1)  
(PO1)
- ```
Depts (NAME (pk) , LOCATION, SIZE)
Students (ID (pk) , NAME, CGPA, DEPT (fk [Depts] ))
Employees (ID (pk) , NAME, DEPT (fk [Depts] ) , JOININGDATE)
```
- Note: Some employees may not be assigned to any department yet.
- Write the standard SQL queries for the followings (query must be case in-sensitive where applicable):
- i. List of the department name and location whose name begins with letter 'C' and ends with 'E'.
 - ii. List of the employees name and designation along with their corresponding department size.
 - iii. List of all employees name and designation along with their corresponding department size if it is available otherwise it will show null (i.e. blank).
 - iv. List of department and its location whose total number students is at least 400.
 - v. List of employees name and designation who are working for more than 5 years.
3. a) There is a danger of using *natural join* construct in SQL. Briefly explain it using example. 5
(CO1)
(PO1)
- b) Differentiate between anonymous and named blocks in PL/SQL. "A function in PL/SQL can return more than one value." Justify it using suitable example. 5 + 5
(CO1)
(PO1)

c) Explain the concept of total and partial participation in E-R diagram. Consider a one-to-many mapping cardinality between entities E_1 and E_2 . In implementation phase, is it possible to ensure total participation for both E_1 and E_2 using any table-level constraint? Justify your position. 10
(CO2)
(PO3)

4. a) Consider the following system description: 5 + 10
(CO3)
(PO2)
 In IUT students are enrolled against a particular department. The Student Information System (SIS) maintains students basic information such as ID, Name and CGPA. Department name, its location are the the relevant information for each department. Courses are offered in each semester. Each course has its code, title and credit hour. Multiple courses are taken by each student. Again one course can be taken by a group of students. The university runs a central board of different societies such as debate, photography and so on. For each society, SIS maintains the name and detailed description of the society. Each student must be attached to exactly one society.

Design the system using standard the E-R Diagram and write the DDL statements to implement it.

b) Consider the following records of STUDENTS Table: 10
(CO1)
(PO1)

Table 1: STUDENTS (Data for Question No. 4 b)

ID	Name	CGPA	Dept
1	a	3.5	CSE
2	b	3.7	EEE
3	a	3.5	CSE

Your task is to split the table into two for both (i) lossless and (ii) lossy decomposition.

5. a) Define functional dependency. What is the basic motivation of using functional dependency in database design? Present example of each type of the following functional dependencies: 2 + 8
(CO1)
(PO1)

- i. trivial
- ii. non-trivial
- iii. semi-trivial
- iv. transitive

b) Briefly mention primary rules of Armstrong's Axioms. Why are they called complete and sound? 5 + 5
(CO1)
(PO1)

c) Is 2NF stricter than 3NF? Briefly explain. Consider the following records of CITIZENS table: 2 + 8
(CO1)
(PO1)
 (Note: the last 3 attributes are namely districts name,size and population)

Table 2: CITIZENS (Data for Question No. 5. c)

ID	Name	DistName	DistSize	DistPolulation(in million)
101	a	Dhaka	Large	20.5
102	b	Rajshahi	Medium	10.2
103	c	Dhaka	Large	20.5
104	a	Khulna	Medium	8.9
105	f	Rajshahi	Medium	10.2

Your task is to verify if the relation is in 3NF. You need to deduce functional dependencies from the given data set. If this is not in 3NF then suggest a loss-less decomposition. (Hint: You do not need to check 2NF condition, just check if it exhibits transitivity dependency for non prime attributes)

- 6. a) Briefly explain why the closure of attributes and concept of superkey are closely linked. Consider the following relation R and functional dependencies (FDs):
 $R(A, B, C, D)$ given FDs: $AD \rightarrow BC$ $B \rightarrow D$ $C \rightarrow A$
Show all steps to determine all possible candidate keys for the above relation. 10
(CO1)
(PO1)

- b) Consider the following relation R and functional dependencies (FDs):
 $R(A, B, C, D, E)$ given FDs: $A \rightarrow C$ $C \rightarrow E$ $B \rightarrow D$ $E \rightarrow A$
Show each step to verify if the given relation is in BCNF. 10
(CO3)
(PO2)

- c) Briefly present a comparative analysis of sparse and dense indexing. Consider the following citizen relation: 5 + 5
(CO2)
(PO2)
 $CITIZEN(ID, Name, BloodGroup, YearlyIncome)$
Here $YearlyIncome$ indicates the exact yearly income of a citizen. Is it wise to apply bit-map indexing on $YearlyIncome$ directly? Justify your position.

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
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SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

CSE 4309: Theory of Computing

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (Six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Compare among Finite automata, Pushdown automata and Turing machine. 6
(CO1)
(PO1)
- b) Design a DFA for the language that does not accept strings containing '00', or '11' as substring over input alphabets $\Sigma = \{0, 1\}$. 6
(CO2)
(PO2)
- c) Finite automata are good models for computers with an extremely limited amount of memory. The controller for an automatic door is one example of it. Design and explain the informal picture of this finite automata with the required states and input conditions. 13
(CO2)
(PO2)
2. a) What are the closure properties of Regular Languages? Using pumping lemma of regular languages, show that the language $L = \{a^n b^n \mid n \geq 0\}$ is not regular. 8
(CO1)
(PO1)
- b) Consider the regular expression: $(0+1)^*0(0+1)^*0(0+1)^*$
Which of the following languages over the alphabet $\{0, 1\}$ is described by this regular expression?
i. The set of all strings containing the substring 00.
ii. The set of all strings containing at most two 0's.
iii. The set of all strings containing at least two 0's.
iv. The set of all strings that begin and end with either 0 or 1. 8
(CO1)
(PO1)
- c) Compute the ϵ -closure of every state of Table 1 and convert the ϵ -NFA to its equivalent DFA 9
(CO3)
(PO2)
- Table 1:** Transition table of an ϵ -NFA for question 2.c)
- | | | | | |
|-----------------|-------------|-------------|-------------|-------------|
| | ϵ | a | b | c |
| $\rightarrow p$ | {q, r} | \emptyset | {q} | {r} |
| q | \emptyset | {p} | {r} | {p, q} |
| * r | \emptyset | \emptyset | \emptyset | \emptyset |
3. a) What do you mean by ambiguous grammar? How can you remove the ambiguity from a CFG? 6
(CO1)
(PO1)
- b) Consider the following grammar: 3+4
(CO2)
(PO2)
- $S \rightarrow A1B$
 $A \rightarrow 0A \mid \epsilon$
 $B \rightarrow 0B \mid 1B \mid \epsilon$
- i. Show that this grammar is unambiguous.
 ii. Find a grammar for the same language that is ambiguous and demonstrate its ambiguity.

- c) Consider the following CFG and construct a PDA equivalent to this CFG and simulate it on the input "010000". 12
(CO3)
 $S \rightarrow 0BB$ (PO2)
 $B \rightarrow 0S \mid 1S \mid 0$
4. a) Explain the following terms: 3
i. Decidability (CO1)
ii. Undecidability (PO1)
iii. Intractability
- b) What do you understand by acceptance by empty stack and acceptance by final state in a Pushdown Automata (PDA)? 8
(CO1)
(PO1)
- c) What is Chomsky Normal Form (CNF)? 2+12
Consider the following grammar: (CO2)
 $S \rightarrow aAa \mid bBb \mid \epsilon$ (PO2)
 $A \rightarrow C \mid a$
 $B \rightarrow C \mid b$
 $C \rightarrow CDE \mid \epsilon$
 $D \rightarrow A \mid B \mid ab$
i. Eliminate ϵ productions.
ii. Eliminate any unit productions in the resulting grammar.
iii. Eliminate any useless symbols in the resulting grammar.
iv. Put the resulting grammar into CNF.
5. a) Prove the following statement: 7
"If $L = N(P_N)$ for some PDA $P_N = (Q, \Sigma, \Gamma, \delta_N, q_0, Z_0)$, then there is a PDA P_F such that $L = L(P_F)$." (CO1)
(PO1)
- b) Design a PDA which accepts the if/else errors by empty stack. What will be the moves for the input string $w = iieee$? 3+3
(CO2)
(PO2)
- c) Suppose the PDA $P = (\{q, p\}, \{0, 1\}, \{X, Z\}, \delta, q, Z)$ has the following transition function: 12
(CO3)
(PO2)
i. $\delta(q, 1, Z) = \{(q, XZ)\}$
ii. $\delta(q, 1, X) = \{(q, XX)\}$
iii. $\delta(q, \epsilon, X) = \{(q, \epsilon)\}$
iv. $\delta(q, 0, X) = \{(p, X)\}$
v. $\delta(p, 1, X) = \{(p, \epsilon)\}$
vi. $\delta(p, 0, Z) = \{(q, Z)\}$
- Convert this PDA into an equivalent CFG.
6. a) What do you understand by Turing Machine? Explain the 7 tuples of a Turing Machine. 3+3
(CO1)
(PO1)
- b) Can you simulate a TM by using a computer? If yes, then how? 7
(CO1)
(PO1)
- c) Design a Turing machine with transition diagram for the language $L = \{a^n b^n c^n \mid n \geq 1\}$. 7+5
(CO2)
Show the tape movements for the string, $w = aabbcc$, for this machine. (PO2)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

Math 4341: Linear Algebra

Programmable calculators are not allowed. Do not write anything on the question paper.
Answer all **6 (Six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Consider the following matrix A : 10+2
(CO3)
(PO1)
- $$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{bmatrix}$$
- i. What would be projection matrix (P) of A to project any vector b onto the columnspace of A ?
- ii. Find P^3 .
- b) Table 1 represents the relationship between the timestamp (t) in hours and total unit of production (u) of an industry on any random day: 11+2
(CO2)
(PO1)

Table 1: Table for Question 1.b)

Timestamp (t)	Total unit of production (u)
-2	1
0	2
2	4
4	5

Find a linear equation that fits these data by minimizing the error. Also, predict the unit of production (u) on the 8th hour of that particular day.

2. a) Consider the following matrix A : 13
(CO1)
(PO1)
- $$A = \begin{bmatrix} 3 & 4 & 6 \\ 0 & 1 & 0 \\ -1 & -2 & -2 \end{bmatrix}$$
- Find a basis of R^3 consisting of eigenvectors of A .
- b) Suppose A is a 3 by 3 matrix with eigenvalues 0, 1 and 2. Identify the following: 4 × 3
(CO3)
(PO1)
- the rank of A
 - the determinant of $A^T A$
 - the determinant of $A + I$
 - the eigenvalues of $(A + I)^{-1}$

3. a) Consider the following sequence S:

$$0, 1, \frac{1}{2}, \frac{3}{4}, \frac{5}{8}, \dots$$

7+7+6
(CO3)
(PO1)

i. Find a matrix A that satisfies

$$\begin{bmatrix} F_{k+2} \\ F_{k+1} \end{bmatrix} = A \begin{bmatrix} F_{k+1} \\ F_k \end{bmatrix}$$

where F_k denotes the k^{th} term of the above-mentioned sequence S.

- ii. Diagonalize the matrix A so that you can easily produce the A^k for any number k. You do not need to multiply the decomposed elements to get a single matrix.
- iii. Find the 100th term of the sequence S.

b) Is it possible to choose all of the eigenvectors of a real symmetric matrix perpendicular to each other? Justify your answer. 5
(CO1)
(PO1)

4. a) Consider the following matrix A:

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

8+7
(CO3)
(PO1)

- i. Find orthonormal vectors q_1, q_2 and q_3 such that q_1 and q_2 form a basis for the columnspace of A and q_3 remains in the left nullspace of A.
- ii. Find the closest vector in the columnspace of A to $b = (1, 2, 7)$.

b) Find the determinants of the following matrices: 5+5

$$C = \begin{bmatrix} -1 \\ 2 \\ 3 \end{bmatrix} \begin{bmatrix} 0 & 5 & 7 \end{bmatrix} \quad D = \begin{bmatrix} 1 & a & a^2 \\ 1 & b & b^2 \\ 1 & c & c^2 \end{bmatrix}$$

(CO3)
(PO1)

5. a) Suppose A is a 3 by 3 matrix with eigenvalues 1, 0 and -1. The eigenvector matrix of A is the following matrix S:

$$S = \begin{bmatrix} -1 & 1 & 1 \\ 0 & -1 & 1 \\ 0 & 0 & -1 \end{bmatrix}$$

10
(CO3)
(PO1)

If matrix B is $B = A^9 + I$, give a reason why the matrix B does have or doesn't have each of the following properties:

- i. B is invertible
- ii. B is symmetric
- iii. $trace = B_{11} + B_{22} + B_{33} = 3$

b) Find the Singular Value Decomposition (SVD) of the following matrix A:

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

15
(CO3)
(PO1)

6. a) Suppose matrix A is the following product:

$$A = \begin{bmatrix} 1 & 0 & 0 \\ 2 & 1 & 0 \\ 3 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 5 \\ 2 & 1 & 0 & 0 \\ 3 & 1 & 1 & 0 \end{bmatrix}$$

12
(CO2)
(PO1)

For what values of t (if any) are there solutions to $Ax = (1, 1, t)$?

- b) Find the conditions on a and b that make the matrix A invertible, and find A^{-1} when it exists:

$$A = \begin{bmatrix} a & b & b \\ a & a & b \\ a & a & a \end{bmatrix}$$

12
(CO1)
(PO1)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
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Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4361: Computer Science and Technology I

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (SIX)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

- | | | |
|-------|--|-------------------------|
| 1. a) | Perform the following conversions: | 2×5 |
| | i. $(426)_8 = (?)_{16}$ | (CO1) |
| | ii. $(678)_{10} = (?)_2$ | (PO1) |
| | iii. $(678)_{16} = (?)_{10}$ | |
| | iv. $(10011011.0111)_2 = (?)_{10}$ | |
| | v. $(932.58)_{10} = (?)_2$ | |
| b) | Differentiate the following: | 3×3 |
| | i. Guided and Unguided Media | (CO2) |
| | ii. STP and UTP | (PO2) |
| | iii. Synchronous and Asynchronous Transmission | |
| c) | Write a program to find whether a given number is even or odd. If found even, check for divisibility by 4, otherwise check for divisibility by 3. | 6
(CO1)
(PO1) |
| 2. a) | Perform the following operations: | 9 |
| | i. $(0011010)_2 + (001100)_2$ | (CO1) |
| | ii. $(0011010)_2 - (001100)_2$ | (PO1) |
| | iii. $(0011010)_2 \times (001100)_2$ | |
| b) | There are five processes $P_1, P_2, P_3, P_4,$ and P_5 having CPU time 6,8,7,3, and 5. Show the CPU execution of these processes using 3 different CPU scheduling algorithms. Also, calculate the waiting time for each process. | 10
(CO2)
(PO1) |
| c) | Describe the LAN, MAN, and WAN transmission technologies in brief. | 6
(CO2)
(PO1) |
| 3. a) | Explain the importance of networking. What are the categories of Guided media? Discuss the features of the categories with figure. | 4+4+8
(CO2)
(PO1) |
| b) | “The bandwidth or the throughput is affected by the distance between the connected computers”- explain the statement. | 6
(CO2)
(PO1) |
| c) | Define Instruction cycle. List down the steps of executing an instruction cycle. | 3
(CO2)
(PO1) |

- 4. a) List the features of the following LAN topologies -
 - i. Bus 3×3
 - ii. Star (CO2)
 - iii. Ring (PO1)
- b) Define multiplexing. Briefly describe the function of each layer of the OSI model. 2+10
(CO2)
- c) Define process. Show the states of a process through a figure. (PO1)
4
(CO2)

- 5. a) Write down the outputs of the following programs. (PO1)
12
(CO1)
(PO2)

```
i.
#include <stdio.h>

int main()
{
  int i;
  for(i=1; i<=10;i++)
    printf("i=%d\n",i);
  return 0;
}
```

```
ii.
#include <stdio.h>

int main()
{
  int p = 800, q, r;

  if (p >= 700)
    q = 600;

  r = 500;

  printf("%d %d\n", q, r);

  return 0;
}
```

- b) What is Memory Management in OS? There are different memory allocation schemes to allocate memory to the processes that reside in memory at the same time. Explain them with appropriate figures. 4+9
(CO2)
(PO1)
- 6. a) Write a C program to draw the following Pyramid Pattern. The number of rows in the pattern should be taken as user Input. Give proper explanation of your code. 15
(CO1)
(PO2)

```

      *
     ***
    *****
   ********
```

- b) Define modulation. Explain different types of modulation. 10
(CO2)
(PO1)

300

06 December 2022

B.Sc. Engg. IPE 3rd Semester

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
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Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

CSE 4373: Computer Programming and Applications

Programmable calculators are not allowed. Do not write anything on the question paper.
Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Explain the concept of control structure in a computer program. How do different control structures regulate the flow of execution of a program? 9
(CO1)
(PO1)
- b) Write a program that will take three integers, **n**, **m**, and **j**, **k**. Then, it will take **two** matrices **A** of size (**n** × **m**) and **B** of size (**j** × **k**). Then, it will evaluate and print a third matrix **C** according to the following equation, 11
(CO2)
(PO2)

$$C = A * B$$
- c) If it is not possible to evaluate the third matrix **C**, then the program will print "Cannot Evaluate". How can you perform multiplication and division operations using shift operators? 5
(CO1)
(PO1)
2. a) In software firms, the codebases are usually stored in separate programs, modules, and files. What kind of programming paradigm are they following? What are its advantages? 8
(CO1)
(PO1)
- b) In a chocolate bar production factory, the size of an ideal chocolate bar is, length: **x**, width: **y**. If the length and width of the produced chocolate bars differ by **0.5** or more from the ideal one, then the bars are rejected; else they are accepted. Write a program that first takes in the values of **x**, **y**, and **n**. Then, the program takes in the lengths and widths of **n** chocolates bars. For each bar, the program either prints "Accept" or "Reject". Sample inputs and outputs of the program are given below. 12
(CO3)
(PO1)

Input
10 5 3
11.5 6
10.4 4.8
9.5 4.5

Output
Reject
Accept
Reject
- c) When is it better to use **switch** statement instead of **if** statements? Explain in brief with examples. 5
(CO1)
(PO1)

3. a) Write a program that reads a very large number (at most 100 digits) from user and prints the sum of the digits in the number. Notice, as the numbers are very large, they cannot be read using integer or long integers. You should read/scan the entire number as a string. A sample input and output of the program is given below. 10
(CO2)
(PO2)

Input

938276718119181209410471091201201202103248324923432432324324324123131314

Output

225

- b) What is the function of “break” and “continue” statements in loops? Explain with examples. 5
(CO1)
(PO1)
- c) Write a program that takes in a number and prints “prime” if the number is a prime; else it prints “not prime”. 10
(CO2)
(PO1)
4. a) Write a program that reads a line/sentence from the console and counts how many words are in it. Hint: you can get the word count by simply counting the number of spaces in the sentence. A Sample input and output of the program is given below. 10
(CO2)
(PO1)

Input

Hello World, I love computer programming!

Output

6

- b) Passwords are always encrypted before they are stored in a file for security purposes. Write a program that reads in a password in the form of a string from the console and replaces every character with its next one in the ASCII table. Then, the program writes the encrypted string in a file named “passwords.txt”. 10
(CO3)
(PO1)
- c) Unlike arrays, it is not necessary to keep track of the length of a string using an integer variable. Mention why? 5
(CO1)
(PO1)
5. a) Using your knowledge of functions and pointers, find out the output of the program given in Figure 1. 10
(CO4)
(PO1)

```
#include<stdio.h>
int f1(int x, int y) {
    x += 10;
    printf("In f1: x = %d\n", x);
    return x + y;
}

void f2(int *x, int *y, int *z) {
    *x += 20;
    *z = *x + *y;
}

int main() {
    int x, y;
    x = 50;
    y = 60;
    int total1 = f1(x, y);
    int total2 = x + y;
    printf("In main: total1 = %d\n", total1);
    printf("In main: total2 = %d\n", total2);
    int total3;
    f2(&x, &y, &total3);
    printf("In main: x = %d\n", x);
    printf("In main: total3 = %d\n", total3);
}
```

Figure 1: C Program for Question 5.a)

b) Using your knowledge of pointers, find out the output of the program given in Figure 2.

7
(CO4)
(PO1)

```

#include<stdio.h>
int main()
{
    int a[] = {2, 5, 6, 20, 3};
    *(a+2) = 12;
    *a = 3;
    int *p = a;
    *p = 10;
    for( ; p<a+5 ; p++)
    {
        printf("%d ",*p);
    }
    return 0;
}

```

Figure 2: C Program for Question 5.b)

- c) i. What is the purpose of passing "r", "w", "r+", "w+" in fopen() function?
- ii. What is the use file pointer? What does it point to?

4+4
(CO1)
(PO1)

```

6. a) struct Student{
        int id;
        char *name;
        int math;
        int physics;
    } students[100];

```

10
(CO2)
(PO1)

Assume that the above array of structures is part of a result processing system and contains the following information of 100 students – their ID, name, marks in math exam and marks in physics exam. Assume the array of structures is declared globally, i.e., they can be accessed from any function in the program.

- i. Write a function **void highest_math()** that prints the name of the student who has the highest total marks.
 - ii. Write a function **double get_average_physics()** that returns the average of all the students' marks in the physics exam.
- b) Using your knowledge of function and recursion, find out the output of the program given in Figure 3.

7
(CO4)
(PO1)

```

#include<stdio.h>

void f(int i)
{
    if(i>10)
        return;
    f(i+1);
    printf("%d\n", i);
}

int main()
{
    f(1);
}

```

Figure 3: C Program for Question 6.b)

- c) Consider Figure 4 code snippet and explain how **Union**, **Enum**, and **Struct** is used to implement a **variable** which can store either a floating-point decimal or an integer.

8
(CO1)
(PO1)

```
union {
    float f;
    int i;
} my_union;

enum {
    its_a_float,
    its_an_int
} variable_type;

struct {
    variable_type x;
    my_union u;
} variable;
```

Figure 4: Code snippet for Question 6.c)

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4501: Operating Systems

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (six)** questions. Figures in the right margin indicate full marks. Whereas data inside parentheses indicate course outcome and program outcome of the questions.

1.

Table 1: Process Scheduling Parameters

Process	Arrival Time	Priority	CPU Burst (t_n)
P_1	0	3	16
P_2	2	1	5
P_3	6	4	2
P_4	7	5	10
P_5	10	2	3
P_6	15	1	7

With short term scheduling, there is no way to know the length of the next CPU burst. However, its value can be predicted, where it is assumed that the next CPU burst will be similar in length to the previous ones. In more general terms, CPU bursts are predicted using the following formula –

$$\tau_{n+1} = \alpha \times t_n + (1 - \alpha) \times \tau_n,$$

where

τ_{n+1} = Predicted value for the next CPU burst.

t_n = Length of the n^{th} CPU burst.

τ_n = The value of n^{th} predicted CPU burst.

α = Controls the relative weight of the newer and older values. Consider $\alpha = 0.5$.

Considering this information and those in Table 1, answer the following Questions -

- a) Generate the list of predicted CPU bursts for the 5 processes using the formula mentioned above. For the first process, P_1 , consider the value of τ_0 as 20 units. 3
(CO1)
(PO1)
- b) Using the predicted burst times (τ_i) of the processes along with relevant information from Table 1, calculate the *average waiting times*, *average turnaround times*, and *average response times* of the processes for the following scheduling algorithms with appropriate Gantt charts – 8 × 2
(CO3)
(PO1)
 - i. Round Robin (RR) [Quantum Value, $q = 5$], and
 - ii. Preemptive Priority Scheduling
- c) Using the same value of q for Round Robin (RR) from (b), show a comparative analysis of the impact of quantum value on the *average waiting* and *turnaround times*, while solving for the burst times predicted from (a) and those given in Table 1, in a graphical manner. Do you have any recommendation for the value of q to mitigate any negative impact on system performance using RR? 6
(CO4)
(PO2)

2. a) Briefly describe the following topics with suitable example(s) and/or diagram(s) –

3 × 4
(CO1)
(PO1)

- i. Parallelism vs Concurrency
- ii. Race Condition
- iii. Deadlock characterization

4 + 3 + 6
(CO1)
(PO1)

b)

Table 2: Process Scheduling Parameters

Process	Allocated					Requested				
	R ₁	R ₂	R ₃	R ₄	R ₅	R ₁	R ₂	R ₃	R ₄	R ₅
P ₁	1	0	0	1	0	0	0	1	0	0
P ₂	1	1	0	0	0	0	0	0	0	1
P ₃	0	1	1	0	0	0	0	0	1	0
P ₄	0	1	0	0	1	1	0	1	0	0

Suppose an operating system has 5 different resources, R₁, R₂, R₃, R₄, and R₅ with 2, 3, 1, 1, and 1 instance(s), respectively. Now consider the information in Table 2, involving 4 processes P₁~P₄ and answer the following –

- i. Draw the *Resource-Allocation* and the *Wait-For* graphs for these processes.
- ii. How will you detect whether the system is in a deadlock state from the Resource Allocation Graph? Explain.
- iii. Is the current system, as shown in Table 2, in a deadlock state? If yes, then list all the clusters of processes that are in a deadlock and in how many ways can this deadlock situation be handled?

3.

A common problem in shell script is that it has no provision for floating point numbers. Write a shell script named `floater.sh`, that takes *three* numbers as parameters and generates a string representation of the result in decimals up to *n*-significant digits. The *first* parameter of the script is the dividend, the *second* one is the divisor, and the *third* one is the approximation of the result up to *n*-significant digits after decimal. Your script should support the following requirements-

5 × 5
(CO2)
(PO2)

- While executing the script without the parameters, syntax error should be raised and must be addressed with a prompt of the following nature

```
$./floater.sh
Syntax Error!!
For more information type: ./floater.sh -h
```

- When the script is invoked with a `-h` flag, the output should be the following.

```
$./floater.sh -h
- Usage : ./floater.sh <number_1> <number_2> <number_3>
-- Parameter 1 <number_1> : Dividend.
-- Parameter 2 <number_2> : Divisor (must be greater than zero).
-- Parameter 3 <number_3> : Number of significant digits after the decimal point.
```

- You should ensure that the *n*th digit of the quotient is rounded up, if the (*n* + 1)th digit is greater than 5.
- You should check for division by zero error.
- The input and output of your script should have the following format:

Input	Output
<code>./floater.sh 2 3 4</code>	0.6667
<code>./floater.sh 5 3 3</code>	1.667
<code>./floater.sh 5 0 3</code>	Division by zero Error!!

4. a) What are the benefits of a *Multilevel Feedback Queue* over a *Multilevel Queue*? Explain with a suitable example and proper illustrations. 12
(CO1)
(PO1)
- b) Elaborate on the different issues of Remote Procedure Calls (RPC) with proper solutions to resolving each of them. 13
(CO1)
(PO1)
5. Consider a system with 5 processes, $P_1 \sim P_5$, and resources of 3 types - A, B, and C with 12, 8, and 10 instances, respectively. The snapshot of the system at time t_0 , is shown in Table 3 and the resource requests by each of the processes at time t_1 , is shown in Table 4. Based on these information, answer the following questions-

Table 3: System Snapshot at time t_0 .

Process	Available			Allocation			Max		
	A	B	C	A	B	C	A	B	C
P_1				0	1	0	8	6	3
P_2				2	0	1	5	1	2
P_3	3	3	3	3	2	2	7	5	4
P_4				2	1	4	2	3	5
P_5				2	1	0	6	4	1

Table 4: Resource Request by processes at time t_1 .

Process	Request		
	A	B	C
P_1	0	0	2
P_2	2	0	0
P_3	1	1	1
P_4	0	0	1
P_5	2	1	1

- a) Find whether the system is in a safe state. [Show step-by-step execution.] 10
(CO4)
(PO2)
- b) Based on the snapshot at time t_0 , as shown in Table 3, mathematically illustrate whether the requests (0, 1, 0) and (1, 1, 1) generated by P_4 and P_2 , respectively, will be granted or not. If they are granted, generate a snapshot of the system at time t_1 , consisting of the updated values of the corresponding data structures. Based on this snapshot, detect whether the requests, as shown in Table 4, will put the system in a deadlock or not. 15
(CO4)
(PO2)

6.

```
do{
    waiting[i] = true;
    key = true;
    while (waiting[i] && key) key = testAndSet(&lock);
    waiting[i] = false;

    // CRITICAL SECTION

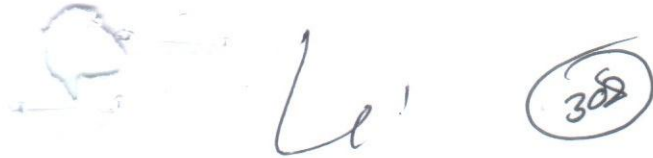
    j = (i + 1) % n;
    while (j != i && !waiting[j]) j = (j + 1) % n;
    if(j == i) lock=false;
    else waiting[j] = false;

    // REMAINDER SECTION
}while(true);
```

Figure 1: Partial code snippet for Question 6.

- a) What do you understand by the Critical Section Problem (CSP)? What are the requirements that a solution to the CSP must satisfy? 4 + 6
(CO1)
(PO1)

- b) Considering the partial code snippet, as shown in Figure 1, show that it satisfies all the requirements of a solution to the CSP, involving two processes P_0 and P_1 . 15
(CO4)
(PO1)


ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4501: Operating Systems

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

-
- | | | | |
|----|----|---|-------------------------|
| 1. | a) | What are the Process States? Briefly describe them. Explain with the proper diagram, how a newly created process transit from one state to another. | 2+3+5
(CO1)
(PO1) |
| | b) | What is Remote Procedure Call (RPC)? Describe the RPC technique in detail with its advantages and disadvantages. | 2+8
(CO1)
(PO1) |
| | c) | <i>"The long-term scheduler controls the degree of multiprogramming in an Operating System."</i> - Give the required explanations for your position, whether you agree or disagree with the statement. | 5
(CO2)
(PO2) |
| 2. | a) | Write a thread program where the main thread takes inputs from the users. Users can only give two types of inputs: one (1) or zero (0) . If the input is one (1) , the main thread will create a worker thread. Worker threads keep printing " Hello " until they are closed by the main thread.
If the input is zero (0) , the main thread closes one of the worker threads. If there are no worker threads, it will print " No Worker Threads ".
The main thread keeps taking user input while the worker threads are running. (Use the POSIX thread library to implement the program.) | 10
(CO5)
(PO2) |
| | b) | Implement the program asked in 2. a) using process and pipe (for IPC). (Use the POSIX thread library to implement the program.) | 10
(CO5)
(PO2) |
| | c) | What resources are used when a thread is created? How do they differ from those used when a process is created? | 5
(CO1)
(PO1) |
| 3. | a) | IUT is considering an enhancement to the processor of its web server. IUT has bought a new CPU for the server. The new CPU is 20 times faster on search queries than the old processor. The old processor is busy with search queries 70% of the time. What is the speedup gained by integrating the enhanced CPU? | 8
(CO4)
(PO1) |
| | b) | Consider a multiprocessor system and a multithreaded program written using the many-to-many threading model. Let the number of user-level threads in the program be greater than the number of processors in the system. Discuss the performance implications of the following scenarios. | 4+4+4
(CO2)
(PO2) |

- i. The number of kernel threads allocated to the program is less than the number of processors.
 - ii. The number of kernel threads allocated to the program is equal to the number of processors.
 - iii. The number of kernel threads allocated to the program is greater than the number of processors but less than the number of user-level threads.
- c) "All child processes eventually turn into zombie processes, but not always into orphan processes." Explain the statement. 5
(CO1)
(PO1)
4. a) What is a Deadlock? Write down the necessary conditions to arise a deadlock situation. 1+4
(CO1)
(PO1)
- b) Race conditions are possible in many computer systems. Consider a banking system with two functions: deposit(amount) and withdraw(amount). Assume a shared bank account exists between a husband and wife and concurrently the husband calls the withdraw () function and the wife calls deposit (). Describe how a race condition is possible in this scenario and what might be done to prevent the race condition from occurring. 10
(CO4)
(PO2)
- c) What is a critical section problem in process synchronization? What are the three (3) requirements of the critical section problem? Explain all the requirements of the critical section problem to help the system preserve data consistency and minimize process starvation. 2+3+5
(CO1)
(PO1)
5. a) Although the Shortest Job First (SJF) algorithm is the best of all CPU scheduling algorithms yet it is not possible to implement practically. Explain why it is not possible to implement it practically. Explain the approximated implementable SJF algorithm with an example. 2+3
(CO2)
(PO1)
- b) An Operating system uses the Multi-level Feedback Queue (MLFQ) algorithm to schedule interactive and batch processes. Assume that MLFQ has **three (3)** queues. The first queue schedules in Round Robin (RR) manner with the quantum $q_1 = 2$. The second queue schedules in an RR manner with the quantum $q_2 = 4$. Finally, the third queue schedules in First-Come-First-Serve (FCFS) manner.
Now draw the Gantt chart and calculate the average waiting time of the MLFQ algorithm for the given set of processes in Table 1. The burst time and arrival time is given in milliseconds.

Table 1: Table for Question 5(b)

Process	Burst Time	Arrival Time	Type (Interactive/Batch)
P1	5	0	I
P2	16	1	B
P3	1	3	I
P4	8	5	I
P5	17	7	B

- c) Calculate the predicted burst time using exponential averaging for the fifth process if the predicted burst time for the first process is 10 units and the actual burst time of the first four processes are 4, 8, 6, and 7 units respectively. Given $\alpha = 0.5$. 5+5
(CO4)
(PO2)

Repeat the prediction for $\alpha = 0.8$.

6. a) The *compare_and_swap* is a hardware synchronization tool for the critical section problem. 10
 The solution with the *compare_and_swap* instruction fails to satisfy all of the requirements (CO2)
 of the critical section problem. Modify the solution to meet all **three (3)** requirements of (PO3)
 the critical section problem.

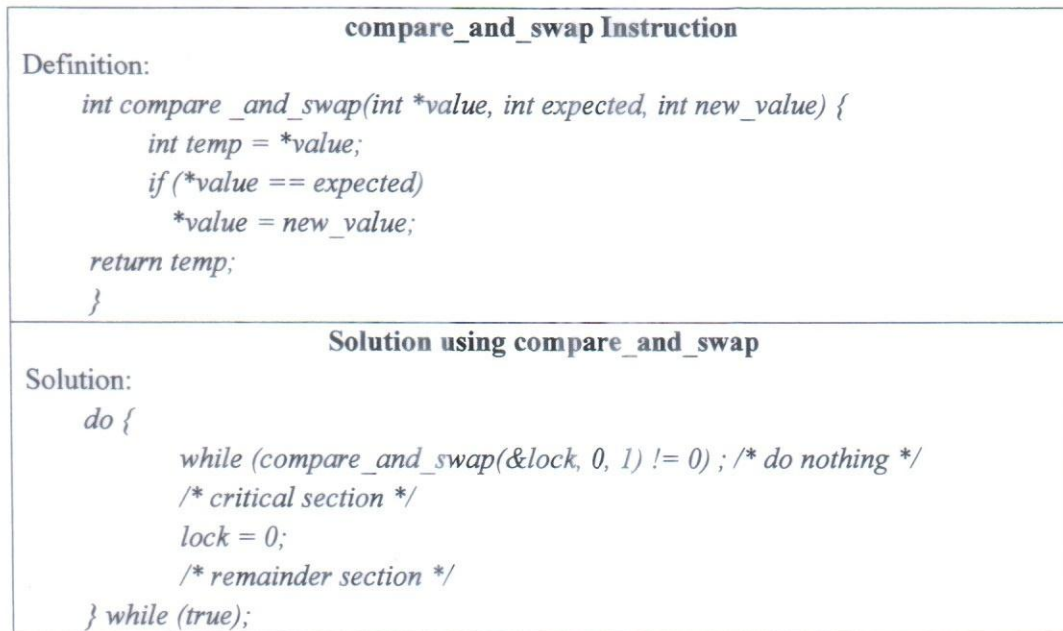


Figure 1: *compare-and-swap* Instruction

- b) The Dining Philosopher Problem is a classical synchronization problem. In the Dining Philosopher Problem, K philosophers dine together at the same circular table having a plate in front of them. There is a fork between each plate. The dish served is a kind of spaghetti which has to be eaten with two forks. Each philosopher can only alternately think and eat. Moreover, a philosopher can only eat spaghetti when they have both a left and right fork. Thus, two forks will only be available when their two nearest neighbors are thinking, not eating. After an individual philosopher finishes eating, they will put down both forks. The problem is to design an algorithm so that no philosopher starves. The faulty design may result in a Deadlock. 3+7
 (CO2)
 (PO2)
- i. Mention at least three (3) approaches to designing the algorithms.
 - ii. Write a pseudo code with the semaphore implementation so that no philosopher starves.
- c) What is the meaning of the term busy waiting? Can busy waiting be avoided altogether? 2+3
 Explain your answer. (CO1)
 (PO1)

Li

311

B.Sc. Engg. SWE 5th Semester

06 November 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 100

SWE 4501: Design Pattern

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) What are the main components of OOP? Discuss the advantage and disadvantage of using Composition over Inheritance. 1+2
(CO1)
(PO1)
6
- b) Indicate for each case which design pattern you will use: (CO4)
(PO2)
- i. Be able to replace the implementation of an interface at run time.
 - ii. Decoupling clients of a system X from dependencies on subsystems of X.
 - iii. Providing clients with a reference to an object of type X but defer the creation of an expensive object of type X until it is needed.
 - iv. Defining a new operation without changing the classes of the elements on which it operates.
 - v. Restoring state of an object to a previous state.
 - vi. Promoting invocation of a method on an object.
- c) Hollywood principle states that "Don't Call Us, We'll Call You". Identify a pattern satisfying this principle. Write a code example for that pattern and explain how your code satisfies this principle. 1+4+4
(CO4)
(PO2)
4
2. a) What are the relationships between the Facade and Abstract Factory pattern? (CO3)
(PO2)
10
- b) (CO4)
(PO2)

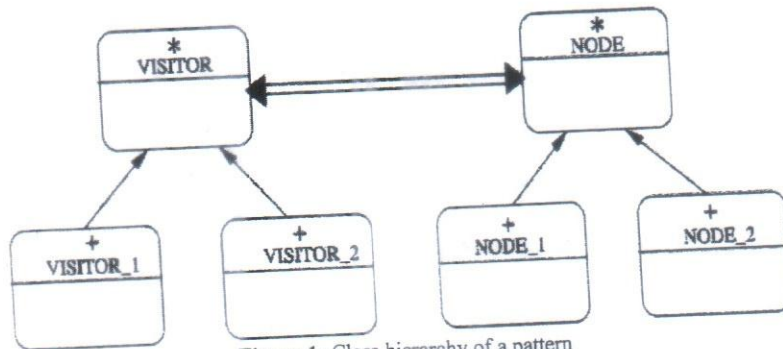


Figure 1: Class hierarchy of a pattern

Answer the following questions according to Figure 1.

- i. Describe the features required in each deferred class, and a typical effective class in each hierarchy, to support the pattern.
- ii. Suppose a class, NODE_C is added as a subclass of NODE. List and describe the required changes to all of the classes affected by the addition.
- iii. Would you advise using the Visitor Pattern if the NODE hierarchy is changed frequently? Justify your answer.
- iv. Describe the type of applications that are suitable for the Visitor Pattern.
- v. Explain the term "Double Dispatch" in Visitor Pattern.

- 3. a) An application for optimizing nurse rosters contains persons and shifts. A person has a number of shifts in his roster, and each shift may be divided into several sub-shifts. You are part of a group tasked to build a general roster traversal algorithm that will generate new rosters based on existing ones.
 - i. Draw a UML diagram representing people, rosters, shifts, and sub-shifts.
 - ii. How would you traverse rosters to summarize shift times? Provide code/ pseudo code of your implementation.
 - iii. Name relevant design patterns used as part of your design and explain how they are used.
- b) Perform a comparative analysis among Singleton, Prototype and Flyweight.

5
(CO3)
(PO1)
5
(CO4)
(PO1)
- 4. a) Use Composite Pattern to model the notion of a folder in Windows XP. Folders may be nested and may also contain text files and binary files. Files may be opened, closed, or drawn on the screen. Folders may also have items added and removed from them. Draw the UML diagram for the described model.

5
(CO4)
(PO1)
- b) Which design pattern restores the state of an object to a previous state? Write a code example of restoring a previous state of an object.

5
(CO4)
(PO1)
- c) Describe the intent and motivation of Builder pattern. What are the differences between Builder and Factory Pattern?

2+2
(CO3)
(PO1)
5
(CO4)
(PO2)
- 5. a) Draw a UML diagram for Mediator pattern between web services and web clients. As web services, the eBay auction house and Amazon are available. Plan functions to search for an item with a textual description, and to buy an item from the service that gives the best price.

5
(CO4)
(PO2)
- b) Identify two design patterns which reduce memory footprint. Perform comparative analysis between them.

5
(CO4)
(PO2)
- c) Identify a pattern which decouples an abstraction from its implementation so that the two can vary independently. Explain a scenario satisfying the statement.

5
(CO4)
(PO2)
- 6. a) Write short notes on – “Refused Bequest” and “Large Class”.

5
(CO2)
(PO1)
- b) Consider the following code snippets –


```

public class Rental {
    private Movie _movie;
    Private int _daysRented;

    public Rental (Movie movie, int daysRented) {
        _movie = movie;
        _daysRented = daysRented
    }

    public int getDaysRented() {
        return _daysRented;
    }

    public Movie getMovie() {
        return _movie;
    }

```

5×3
(CO2)
(PO2)

```

public double amountFor() {
    double thisAmount = 0;

```



```
//determine amounts for each line
switch (getMovie().getPriceCode()) {
    case Movie.REGULAR:
        thisAmount += 2;
        if (getDaysRented() > 2)
            thisAmount += (getDaysRented() - 2) * 1.5;
        break;
    case Movie.NEW_RELEASE:
        thisAmount += getDaysRented() * 3;
        break;
    case Movie.CHILDRENS:
        thisAmount += 1.5;
        if (getDaysRented() > 3)
            thisAmount += (getDaysRented() - 3) * 1.5;
        break;
}
return this.Amount; }
}
```

```
public class Movie {
    public static final int CHILDRENS = 2;
    public static final int REGULAR = 0;
    public static final int NEW_RELEASE = 1;

    private String _title;
    private int _priceCode

    public Movie (String title, int priceCode) {
        _title = title;
        _priceCode = priceCode;

        public int getPriceCode() {
            return _priceCode;
        }
        public void setPriceCode(int arg) {
            _priceCode = arg;
        }
        public String getTitle() {
            return _title;
        }
    }
}
```

- i. Briefly explain the terms "Code refactoring" and "Code smell".
- ii. Identify two code smells which have occurred in the code.
- iii. Refactor the code by removing the smells.

Li (314)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

SWE 4503: Software Security

Programmable calculators are not allowed. Do not write on the question paper.

Answer **all six (6) questions**. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Consider a website where the *PHP* is used on server side and *MySQL* as database. The following script shown in Figure 1 is used to retrieve data from database. Is this *PHP* code vulnerable to *SQL injection*? If so, give two effective approaches to prevent *SQL Injection*. 13
(CO2)
(PO2)

```
<?php
$username=$_POST['username'];
$_SESSION['usremail'] =$username;

$usrpassword= $_POST['passwd'];
$db= mysql_select_db('mydb',$connection);
$result= mysql_query("select usrfname,usrlname
                    from userinformation
                    where usremail='$username' and usrpassword='$usrpassword'") or
die ('failed to login');
?>
```

Figure 1: Code snippet for Question 1.(a)

- b) The two C programs shown in Figure 2 and Figure 3 do not exhibit any compilation error. Are these C programs secure? If so, justify your claim. If your answer is no, then mention the appropriate corrections to secure those issues. 14
(CO2)
(PO2)

```
#include <stdio.h>
#include <unistd.h>

int main(int argc, char **argv) {
    char cat[] = "cat ";
    char *command;
    unsigned int commandLength;
    commandLength = strlen(cat) + strlen(argv[1]) + 1;
    command = (char *) malloc(commandLength);
    strncpy(command, cat, commandLength);
    strncat(command, argv[1], (commandLength - strlen(cat)));
    system(command);
    return 0;
}
```

Figure 2: Code snippet for Question 1.(b)

```
#include <stdio.h>

int main() {
    unsigned int num, i;
    char message[20]="Hello world!";
    int numbers[4]={1,2,3,4};

    scanf("%d",&num);
    for (i=0;i<=num;i++){
        printf("%c\t", message[i]);
    }
    if((numbers[4]/num)%2==0){
        printf("\nNumber Authenticated");
    }
    else
        printf("\nNumber Not Authenticated");
    return 0;
}
```

Figure 3: Code snippet for Question 1.(b)

2. *Elgg* is a web based social-networking application which is hosted at the domain named "www.elgg.com". Alice and Sammy are two members of *Elgg* social network. Sammy wants to become a friend to Alice, but Alice refuses to add him to her *Elgg* friend list. Sammy decides to use the *Cross-Site Request Forgery (CSRF)* attack to achieve his goal. Hence, Sammy decides to host a vulnerable website.

Sammy sends Alice a *URL* through an email. Alice, curious about it, clicks on the *URL*, which leads her to Sammy's web site.

- a) Pretend that you are Sammy. Now describe the detailed steps to construct the content of this vulnerable website, so as soon as Alice visits the web page, Sammy is added to the friend list of Alice. Assume the values of relevant variables if required in constructing the website content. 8
(CO1)
(PO1)
- b) Is there any pre-requisite for the success of Sammy's attempt here? Justify your answer with appropriate argument. 4
(CO1)
(PO1)
- c) How can *CSRF* attacks be prevented? Justify your answer. 6
(CO1)
(PO1)

3. a) Suppose *main()* function of a c program calls a function named *fun*. After all the commands of *fun()* function have executed, how does the program know where to continue at the exact location in *main()* where it left off? 7

b) Alice is building a server that runs the code sequence listed in Figure 4. Assume that the server is a *Compromised Server* and Sammy is a *Co-located User* there. 19
(CO1)
(PO1)

Sammy wants to exploit the buffer overflow attack by exploiting bugs in Alice's server. Explain how Sammy can exploit a buffer overflow in his code to delete files on the server.

- i. List the steps that Sammy needs to follow in accomplishing the attack.
- ii. Mention the pre-requisite conditions to successfully exploit the overflow.
- iii. Draw a stack diagram to show what locations on the stack Sammy needs to control.

iv. What values he proposes to write there, and where in the input string these values need to be located?

You can assume any sample values for stack memory addresses and content of *Shell Code* if it required.

```

#ifndef BUF_SIZE
#define BUF_SIZE 100
#endif

int bof(char *str)
{
    int authenticated = 0;
    char buffer[BUF_SIZE];
    if(authenticated) {
        strcpy(buffer, str);
    }
    return 1;
}

int main(int argc, char **argv)
{
    char str[517];
    FILE *badfile;
    badfile = fopen("badfile", "r");
    fread(str, sizeof(char), 517, badfile);
    bof(str);
    printf("Returned Properly\n");
    return 1;
}

```

Figure 4: Code snippet for Question 3.(b)

- 4. a) Mention the sequential activities involved in different phases of *Secure Software Development Lifecycle (Secure SDLC)*. 7
(CO4)
(PO1)
- b) "It is easier and more cost-effective to eliminate security *Flaws* at the *design level* than in any other phase of the *secure SDLC*"- Justify the claim with proper argument. 4
(CO3)
(PO1)
- c) Alice, a security requirement analyst has set several security requirements for an ongoing Banking Software Development. One of the Security Requirements is listed below. 8
(CO2)
(PO2)

 Security Requirement: "One user's bank account balance should not be learned by, or modified by, another user, unless authorized"

 Llist the required *Security Mechanisms* for enforcing them.
- d) What are the pros and cons of *Static Analysis* and *Dynamic Analysis* of a software program? 7

5. a) Distinguish between a *Monoalphabetic Cipher* and a *Polyalphabetic Cipher* with appropriate example. 5
- b) Are all *Stream Ciphers Monoalphabetic*? Explain. 6
- c) Use the *Playfair Cipher* to encipher the message "*The key is hidden*". The secret key can be made by filling the first and part of the second row with the word "*GUIDANCE*" and filling the rest of the matrix with the rest of the alphabet. 12
6. a) Mention few specific guidelines to prevent *Broken Authentication*. 9
- b) With the aid of a diagram clarify the concept of *Digital Envelop*. 6
- c) Explain two applications of *Public Key Cryptography*. 6
- d) Suppose that we have a *Block Cipher* where $n = 64$. If there are 36(thirty-six) 1's in the ciphertext, how many trial-and-error tests does Eve need to do to recover the plaintext from the intercepted ciphertext in each of the following cases? 9
(CO2)
(PO2)
- i. The cipher is designed as a *Substitution Cipher*
 - ii. The cipher is designed as a *Transposition Cipher*

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

CSE 4511: Computer Networks

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **3 (three)** questions. Marks of each question and the corresponding CO and PO are written in the right margin with brackets.

- 1. a) Explain why a minimum frame size is required for Ethernet. For example, standard (10Base) Ethernet impose a minimum frame size constraint of 64 bytes. Derive a formula to find the minimum frame size needed for an Ethernet packet where the distance between two ends of an Ethernet LAN is *d*. 4+4
(CO1)
(PO1)
- b) Can RTS-CTS hand-shaking completely eliminate the hidden station problem? If YES, then justify how the RTS-CTS hand-shaking avoids the collision from hidden nodes. If NO, then draw a frame exchange scenario where a collision occurs due to hidden nodes. 7
(CO1)
(PO1)
- c) Demonstrate the looping problem of a transparent bridge with appropriate diagrams. Mention possible solutions to overcome the problem. 10
(CO1)
(PO1)
- 2. a) The Cache-Control Module of ARP package is responsible for maintaining the cache table. Assume that Table 1 is the state of original cache table. Analyze the task of Cache-Control module and draw the cache table for each of the following events. 10
(CO2)
(PO2)
 - i. The ARP output module receives an IP datagram (from the IP layer) in the current instance of time with the destination address 114.5.7.89.
 - ii. Twenty seconds later, the ARP output module receives an IP datagram (from the IP layer) with the destination address 116.1.7.22.
 - iii. Fifteen seconds later, the ARP input module receives an ARP packet with target protocol (IP) address 188.11.8.71.
 - iv. Twenty-five seconds later, the cache-control module updates every entry.

Table 1: Table for question (3.a)

State	Queue	Attempt	Time-Out	Protocol Address	Hardware Address
R	5		900	180.3.6.1	ACAE32457342
P	2	2		129.34.4.8	
P	14	5		201.11.56.7	
R	8		450	114.5.7.89	457342ACAE32
P	12	1		220.55.5.7	
F					
R	9		60	19.1.7.82	4573E3242ACA
P	18	3		188.11.8.71	

- b) What is the purpose of including the IP header and the first 8 bytes of datagram data in the error reporting ICMPv4 messages? Under what circumstances no ICMPv4 error messages is generated? 5
(CO2)
(PO1)
- c) An ISP is granted a block of addresses starting with 130.15.0.0/16. The ISP wants to distribute these blocks to 320 customers as follows: 10
(CO2)

- i. The first group has 64 customers; each needs 256 addresses (PO2)
- ii. The second group has 128 customers; each needs 128 addresses
- iii. The first group has 128 customers; each needs 64 addresses

Design the sub-blocks and show the address allocation and distribution by the ISP. Find out how many addresses are still available after these allocations.

3. a) "Stream control transmission protocol (SCTP) is reliable transport protocol that combines the good features of UDP and TCP" – Justify the statement. 5 (CO2) (PO1)
- b) i. Show the abbreviated form of the following IPv6 address: 0000:00AA:1111:0000:0000:0000:119A:A231 4 (CO2)
- ii. Show the original form of the following address: 1234::1:2 (PO1)
- c) Explain the challenges associated with the transition from IPv4 to IPv6, and mention the methods to be used during the transition process. 8 (CO2) (PO2)

OR

What is IP address space depletion? Briefly explain different measures to handle IP address depletion. 8 (CO2) (PO2)

- d) Compare IPv4 options and IPv6 extension headers. Mention the benefit of dropping the checksum field from IPv6 header. Does it introduce any potential danger of forwarding erroneous packets by IPv6? Explain. 8 (CO2) (PO2)

4. a) Consider the network shown in Figure 1 where each node initially knows the costs to each of its neighbors. Consider the distance-vector algorithm and show the distance vector/table entries at node X that is shared with its neighbors. How does the scenario change if we use link state algorithm instead of distance vector algorithm? 7 (CO3) (PO2)

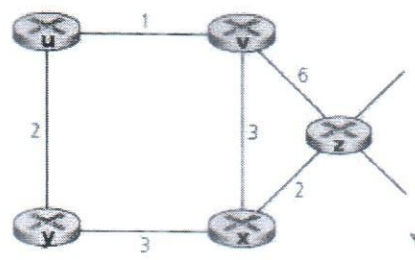


Figure 1: Network for question (4.a)

- b) Consider the network given in the Figure 2. With the indicated link costs, use Dijkstra's shortest-path algorithm used in link state routing to compute the shortest path from V to all network nodes. Prepare the routing table for node V. 12 (CO3) (PO2)

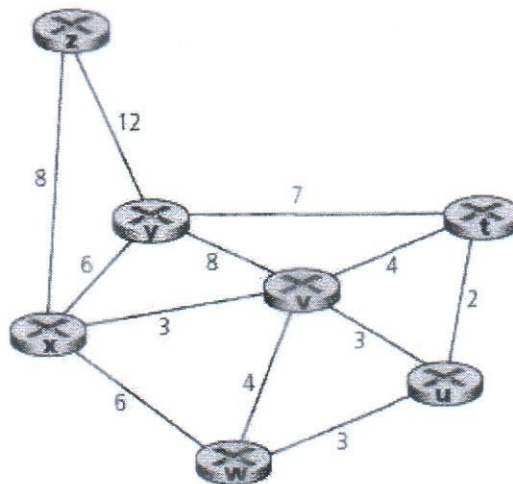


Figure 2: Network for question (4.b)

c) Differentiate between distance-vector routing and path-vector routing. Mention some of the methods to eliminate the C2I (Counting to Infinity) problem of distance-vector routing. 6
(CO3)
(PO2)

5. a) Neatly sketch the state transition diagram of TCP connection establishment and connection termination. TCP opens a connection using an initial sequence number (ISN) of 23. The other party opens the connection with an ISN of 17. 10
(CO2)
(PO2)

- i. Show the three TCP segments during the three-way handshaking connection establishment.
- ii. Show the contents of the segments during the connection termination using four-way handshaking with half-close.

Use two timelines for each side to show the states and the relative duration of the client and the server.

OR

TCP uses sliding window technique for flow control. The sender has sent bytes upto 202 and the receiver has sent an acknowledgment number of 200 with an rwnd of 12 bytes (assume the cwnd is 20). Depict the current window. 10
(CO2)
(PO2)

After some time the sender has received an acknowledgment value of 204 and an rwnd of 6. Draw the new window. Is there any problem with the new window? If yes, explain the problem with the possible solution.

b) The following is a dump of a TCP header in hexadecimal format. 5
(CO2)
(PO2)

(05320017 00000001 00000000 500207FF 00000000)₁₆

- i. What is the destination port number?
- ii. What is the acknowledgment number?
- iii. What is the length of the header?
- iv. What is the type of the segment?
- v. What is the window size?

c) With the aid of necessary equations and diagrams explain how the value of Retransmission Time-Out (RTO) is calculated for the Retransmission timer. Your answer should include a scenario incorporating the Karn's algorithm. 10
(CO2)
(PO2)

6. a) SCTP uses a four-way handshaking for an association establishment, whereas TCP uses a three-way handshaking for a connection establishment. What are the improvements of SCTP association establishment with the cost of an extra message passing? An SCTP client opens an association using an initial tag of 2200, an initial TSN of 11111, and a window size of 6
(CO2)
(PO2)

30000. The server responds with an initial tag of 1100, an initial TSN of 250, and a window size of 15000. Show the time-line diagram of the association establishment.

- b) Explain the following concepts with respect to SCTP:
- i. Multihoming ii. Verification Tag iii. HEARTBEAT chunk
- 9
(CO2)
(PO2)
- c) How does congestion control differ from flow control and error control? A TCP source sends segments of equal size and maintains the sequence number for each segment (i.e., the TCP protocol is segment-oriented instead of byte-oriented). Assume that the sequence number of the first data segment is 125. The size of the receiver window (rwnd) is always larger than the congestion window (cwnd). For the first data segment, assume that the value of the cwnd is 1, and the value of the slow start threshold (sssth) is 65000. Draw a timing diagram for the transmission of segments, where the y-axis shows the time, and two parallel lines in the y-axis represent the events (sending and receiving of data and ACK segments, cwnd values, etc.) at the source and destination TCP. Assume that the source always tries to send as many data segments as it is allowed. Consider the following while giving your answer:
- The successful transmission of at least 30 segments.
 - Seventh (17th) Segment is lost and the source identifies this by triple duplicate acknowledgments.
 - Fourteenth (24th) Segment is lost (assume subsequent segments are also lost) and the source identifies this by a timeout.
 - At the left side of the source TCP timeline, show the value of cwnd and ssth, whenever they are updated.
 - Identify the slow start, congestion avoidance, and congestion detection region in the source TCP timeline.
- 10
(CO2)
(PO2)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4513: Software Engineering and Object-Oriented Design

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. Dhaka International FolkFest is the biggest folk music festival of Asia. But the tickets have always been sold for such a big event in a traditional way through two events agencies. The organizers decided to completely modernize the ticket selling system as follows:

The tickets will be sold in three distinct ways: traditionally by the two events agencies, in electronic format directly on the festival website, and through Bangladesh Railway (BR). All parties will have access to the same unique ticket database of the new system, to avoid double selling. A partnership with the BR needs to be set up, such that BR can sell combi-tickets including both the festival entry fee and the train ride to the nearest station of festival venue at reduced price. This way, more music fans will have easier and cheaper access to Dhaka International FolkFest. Moreover, the system will have to be extended to support not only English, but also Bengali, Hindi and French. Since tickets will be sold online, SSLCOMMERZ will be contracted to ensure the security of the online payment service. The event manager will take care of and negotiate all these details with the involved parties. Additionally, upon arrival at the festival venue, each participant has to self-check in at a touch screen terminal, which scans the barcodes on his/her ticket and issues a bracelet with an electronic chip. This chip can be used to recharge and spend money, such that whenever (s)he wants to purchase snacks or beverages, (s)he does not have to use cash anymore, thus reducing waiting times. This measure was initiated by the program manager and will be deployed by WristSolutions Inc. Lastly, according to the laws of Bangladesh Bank, the way the payment transactions are performed must be audited by an external company at the end of the festival, since this is a public event, where the city corporation of Dhaka-North is also involved.

- a) Identify and name all the stakeholders of the new ticket selling system. 5
 - b) Identify three functional and two non-functional requirements from the above-mentioned ticketing system. 5
 - c) Identify all the use cases and represent them in a UML use case diagram. 7
 - d) Prepare the use case description for "Purchase Ticket" use case. 8
2. a) What are the challenges in software requirement gathering? What is the main purpose of software maintenance? 3+2
 - b) Suppose you are the project manager for a software product, where you need to develop and deliver an "Election Management System (EMS)". The requirements for EMS are clear. But the EMS needs to confirm the accuracy of data collection and privacy of that data collected. It should also be able to detect fraud cases and manage them, which need deep business understanding and risk management as well as excellent testing cases. 3+5
In the context of this scenario, which software development lifecycle model should be selected? Justify your selection.

- c) Functional Requirements (FRs) define “what” the system should do, and Non-Functional Requirements (NFRs) define operational capabilities and constraints that enhance the functionality. FRs always come as a user story but in many cases NFRs are not included in that user story. How can we confirm the development of all NFRs along with FRs? 5
- d) Consider a software with the following components: EI (simple) = 30, EO (average) = 20, EQ (average) = 35, ILF (complex) = 08, ELF (complex) = 05. In addition, the system requires significant end-user efficiency, moderate distributed data processing, average data communications, and other GSCs are incidental. Compute the function points for this system using FPA. 7
- 3. a) Suppose you are assigned to develop an application for a bank for processing personal loans. What kind of interaction style should you select? 2
- b) What are the two aspects of a software system design that are explicitly omitted from a UML class diagram? 2
- c) Why do we prefer composition more than inheritance in OOD? 4
- d) Consider a workflow system for supporting software developers. The system enables managers to model the process that the developers should follow in terms of activities and work products. The manager can assign specific processes to each developer and set deadlines for the delivery of each work product. The system supports several types of work products, including formatted text, picture, and URLs. The manager, while editing the workflow, can dynamically set the type of each work product at run time. One of your design goals is to design the system in such a way that more work product types can be added in the future. 5+12
 - i. Which design pattern would you use to represent work products? Justify your answer.
 - ii. Draw the Class diagram and Sequence diagram for your chosen pattern.
- 4. a) Consider a Banking application that will ask the user to fill an online personal loan application. Based on the inputs, the application will display in real-time whether the loan will get approval, rejection, or requires a visit to the branch for further documentation and discussion. According to the business logic of the application, if you are salaried and your monthly salary is greater than or equal to 75k, then your loan will be approved. If you are salaried and your monthly salary is between 25k and 75k (exclusive), then you will need to visit the branch for further discussion. If you are salaried and your monthly salary is less than 25k, then your loan will be rejected. If you are not salaried and your monthly income is greater than or equal to 75k, then you will need to visit the branch for further discussion. If you are not salaried and your monthly income is less than 75k (exclusive), then your loan will be rejected, consequently. 8+4 (CO3) (PO2)
- i. Construct the decision table for the aforementioned scenario.
- ii. Prepare the minimum number of test cases to cover the full decision table?
- b) Draw the control flow graph for the scenario given in question 4.a) and find the cyclomatic complexity. 10 (CO3) (PO2)
- c) How does Continuous Delivery differ from Continuous Deployment? 3 (CO3) (PO1)
- 5. a) A web-based ticket booking system expects to handle three times its average number of visitors during the peak booking month of the year. What type of performance test should be conducted to confirm the system’s stability for this requirement? What are the things will you be able to verify through your chosen performance testing? 3+4

- b) Suppose your recent project is almost at the end of its development schedule. It has five modules: home page, login page, new user creation, user details page, and task creation. According to the requirements, the username in the login page should not accept less than six characters, but a bug was registered by the QA team when a username with less than six characters was accepted. QA Team assigned the bug to the development team for fixing. The development team fixes the issue and passes it to the QA team to recheck. 2+5+3
 - i. Which test must be performed by the QA team? Justify your answer.
 - ii. How does your selected testing techniques help in producing a quality software?

- c) In a certain SW development company, developers use a version control system (VCS) which allows them to make parallel changes on the same file, but it does not allow developer to clone the remote repository locally. 3+5
 - i. What type of VCS is the company using?
 - ii. How are merge conflicts handled in such VCS?

- 6. a) How does Continuous Integration help to deliver software more rapidly? 5

- b) Mention the type of maintenance required for the scenarios mentioned below. 3+3
 - i. Assume that you develop an application where users can log in using their credentials of a social network, such as Google or Facebook. Recently, you learned that users are unable to log in to the application using their social network credentials due to a small defect in the application's authentication code that communicates with the social networking platform. A quick update can restore login functionality from the social networking site.
 - ii. Users have been logging in to the application using their Google credentials with no problem for the past few days. Suddenly, all the users are unable to log in to the application using the same approach. An investigation by a software developer discovers that Google has changed the way it authenticates users with its Application Programming Interface (API), meaning that the application must be modified to accommodate this change.

- c) One way of reusing software components is to modify the reusable software component while keeping the user requirements same. Another way is to modify the user requirements while keeping the reusable software component same. 2+5

Which way is more beneficial for the developing company? How can it help companies to generate more profit?

- d) What is software re-engineering? Mention the re-engineering process. 2+5

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B.Sc. Engg. CSE 5th Semester

02 December 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4531: E-Commerce and Web Security

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

-
1. a) With real-life examples, examine industry value chains and firm value chains. 8
(CO1)
(PO2)
- b) The price of daily essentials has increased vastly. Blossom believes finding alternative sources of food will help mitigate the crisis and make a fine business. Buttercup believes she can get a grip of the market by selling things at a cheaper cost. Bubbles on the other hand believes that she can get her business running by improving customer care. 9
(CO1)
(PO3)
- Classify and explain which business strategies each of these girls are using.
- c) Barry Allen is a supporter of the England National Team. He is watching the live stream of FIFA World Cup final match (England VS Bangladesh). While watching the live stream, at one moment he saw that his stream got stuck at the time 30:23 for 5 minutes. But after it resumed, it started from 30:23 again instead of 30:28. So, his real-time stream keeps lagging behind. 8
(CO2)
(PO2)
- Identify what type of transfer layer protocol is being used and suggest an alternative.
2. a) Ross Geller wants to open an antique store where he will sell different valuable artifacts. He wants to attract different collectors. He will also open an E-platform for selling these products online all over the country. He is currently trying to figure out his target audience. 9
(CO2)
(PO2)
- Analyze Ross Gellar's situation and come up with different features which his target audience should have.
- b) You can build your own website or you can outsource the job. Again, the same goes for hosting where you can either host on your own or you can outsource the job. Choose an example of a business for each of the four combinations with proper justification 8
(CO2)
(PO1, PO2)
- c) Consider an E-commerce website Radaz where they sell all kinds of products. In terms of Radaz, analyze the modules which needs to be tested in each of the steps of Unit testing, System testing, Acceptance testing and A/B testing. 8
(CO2)
(PO2)
3. a) Elon Musk has an e-commerce cross platform application where he sells computer and accessories. He also provides repair services. Elon sometimes resells the repaired parts to the customers as brand new. He knows this is wrong but he does it in order to save his employees from losing their jobs. Elon also ensures that the parts he sells are totally functional and he provides sufficient warranty as well so that the customers are not harmed. In this case of Elon's ethical dilemma, explain what should be done considering the Candidate Ethical Principles. 9
(CO5)
(PO8)

- b) Find some advantages and challenges of online retail. (You can use Amazon or any retail company for making the comparison) 6
(CO5)
(PO2)
- c) Explain with proper examples how to analyze the viability of an online firm. Consider both strategic analysis and financial analysis. 10
(CO5)
(PO2)
4. a) Amanat Shah wants to build a business where he sells different clothes to the mass public. His target audiences are more familiar with social network platforms than visiting websites. Using REAN model, examine the steps needed to build his business. 8
(CO3)
(PO12)
- b) "There are some businesses where Multi-channel firms are not a good idea". Analyze the statement with proper logic. 5
(CO3)
(PO12)
- c) John Cena is trying to design his own website. He has created some fancy graphs and motivational posters to highlight his success in the wrestling world. But somehow he is not ranking well and his website is not getting suggested in people's Google searches. Is there any way John can fix this issue? Find possible solutions. 8
(CO2)
(PO2)
- d) Relate the phrase "Content is King" with any marketing campaign that you can think of in real-life. 4
(CO3)
(PO12)
5. a) Explain the instruments of national power that influences cyber actions and analyze how cyber-attacks affect different departments 5+5
(CO4)
(PO1)
- b) Mr. Haque is the CEO of a large E-commerce company. His system is responsible for thousands of transactions each day which can be worth millions of dollars. Is fielding system at the speed of need a good approach in this scenario? Explain with proper justification. 8
(CO4)
(PO1)
- c) Russia has a very strong and intelligent military. It is said that Russia has the best cyber attackers which can produce top quality Computer Network Attacks (CNA). But Russia is also said to have a weak Computer Network Exploitation (CNE) ability in comparison to many other countries. In such scenario, evaluate Russia's military capabilities and provide suggestions to enhance their military strength. 7
(CO4)
(PO1)
6. a) Imagine you are trying to use SQL injection on a login page of a poorly developed website. Evaluate the outcomes (with proper logic) if you put the following strings inside the username field of login: 5×3
(CO4)
(PO1,PO2)
- i. admin' OR '1'='1
- ii. admin'--
- iii. admin' OR 1=1 AND sleep(300)--
- b) Assess in which scenarios Reflective XSS will be better than Stored XSS. Also find scenario where Stored XSS will be better. 3+3
(CO4)
(PO2)
- c) Recommend some techniques of preventing XSS. 4
(CO4)
(PO1)

Library

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

SWE 4537: Server Programming

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Derive the mathematical formula for estimating the false positive rate (fpr) of a t -level hierarchical bloom filter containing m bits after inserting n strings using k hash functions. 8
(CO2)
(PO2)
 - b) To prevent repeat recommendations for an article, the Medium site intends to develop a bloom filter for its users. The false positive rate (fpr) after inserting 10^7 post titles shouldn't be higher than 1%. Calculate the following parameters based on these specifications. 3×4
(CO1)
(PO1)
 - i. Optimal length of the bloom filter in MegaBytes
 - ii. Optimal number of hash functions
 - iii. Approximate number of inserted post titles when 50% of the bits are set to 1
 - c) What makes the bloom filter a probabilistic data structure? Give an example to demonstrate the certainty of no false negatives in bloom filters. 2+3
(CO1)
(PO1)
2. Twitter is a social networking site where users may follow one another and this relationship might be mutual. However, some people may accumulate more followers than others. Tweets are posts made by users on Twitter, although most users do not tweet frequently. Users can interact with tweets in various ways, including like, commenting, and retweeting (sharing a tweet), among others. Tweets are limited to 140 characters and can incorporate photos or videos. Twitter has 500 million users, with a daily active user count of 200 million. There is a 4:1 viewer-to-uploader ratio. On average, each user reads 100 tweets, while each uploader only tweets once per day. The average tweet size is 1 MB (some might contain images, videos, both, or just plain text).
- a) Explain whether Twitter is a read-intensive or a write-intensive system. Calculate how much data Twitter needs to read and write each day. 2+3
(CO1)
(PO1)
 - b) What functional and nonfunctional requirements do you wish to prioritize while designing Twitter? Design Twitter as a microservice architecture and explain the responsibility of each service. 3+12
(CO3)
(PO3)
 - c) Describe the responsibility of Google File System's (GFS) master and client. 5
(CO1)
(PO1)
3. a) A Facebook post has been viewed m times by n unique users. After hashing m userIDs using k ($k = 8$) independent hash functions, the maximum number of trailing zeros obtained from each of these hash functions is shown in Table 1. The actual value of n is 150 and the correction factor, $\theta = 0.77351$. 15
(CO2)
(PO2)

Table 1: Hash function and corresponding obtained number of maximum trailing zeros

k_i	0	1	2	3	4	5	6	7
Maximum number of trailing zeroes	6	11	5	9	7	13	2	3

Estimate the value of n and calculate the error rate using LogLog, SuperLogLog, and HyperLogLog.

- b) Generate the inverse index and document-wise relevance for the term 'thriller' from the following documents using Elastic Search. 10
Document 1: Harry Potter series is not a thriller. (CO1)
Document 2: I love to read thriller novels. (PO1)
Document 3: I prefer TV series over any novel.
Stop-words = [I, is, not, to, over, any]

- 4. a) YouTube, an online video-sharing network, has 100 million daily active users and a viewer-to-uploader ratio of 1000:1. On average, each uploader makes a 5-minute video every day. Estimate YouTube's storage, cache, and processor requirements. 15
(CO2)
(PO2)
- b) Why do popular social networking sites use different notification/newsfeed update mechanisms for celebrity posts? Explain these approaches for both general and celebrity posts. 6
(CO1)
(PO1)
- c) Write short description about the following terms- 2+2
I. Netflix Zuul (CO1)
II. Netflix Hystrix (PO1)

- 5. a) With the appropriate examples, describe the partitioning of secondary indexes by term. Which secondary index partitioning will be more effective in a write-intensive system? Justify your answer. 7+5
(CO1)
(PO1)
- b) Which strategy will you use to choose the appropriate number of partitions for a data-intensive application? Justify your response. 8
(CO2)
(PO2)
- c) In comparison to MessagePack, how does the Protocol Buffer optimize memory requirements for JSON encoding? 5
(CO1)
(PO1)

- 6. a) With the appropriate examples, briefly describe JavaScript's primitive and non-primitive data types. 5
(CO1)
(PO1)
- b) Write down the working procedure of Diffie-Hellman key exchange protocol and its use-cases in client-server communication. 10
(CO1)
(PO1)
- c) Write down the working procedure of Open Authorization v2.0. 10
(CO1)
(PO1)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

CSE 4539: Web Programming

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. You are given an HTML body shown in Figure 1.

```
<body>
  <h1>A Collection of the best recipes ever</h1>
  <article id="recipe-list">
    <ul>
      <li>Holiday Cookies</li>
      <li>Lasagna</li>
    </ul>
  </article>
  <article id="recipe-area">
    <h2>Holiday Cookies</h2>
    <article id="ingredients">
      <ul>
        <li>flour</li>
        <li>sugar</li>
      </ul>
    </article>
    <p class="instruction">Combine all the ingredients.</p>
    <p class="instruction">Wish on a shooting star.</p>
  </article>
</body>
```

Figure 1: HTML code snippet for Question 1

- a) What are tags and attributes in HTML? Explain in detail with the help of Figure 1. 5
(CO1)
(PO1)
- b) Draw the Document Object Model (DOM) tree based on Figure 1 that corresponds to the hierarchy of the body HTML (ignore the text, text nodes, and tag attributes - just refer to tag names in boxes and parent/child relationships with lines between boxes). 10
(CO2)
(PO1)
- c) Style the HTML from Figure 1 with the following requirements: 10
- i. The background color of the entire page should be #123456. (CO2)
 - ii. The color of the text for all the headings should be green. (PO2)
 - iii. Every element with the class *instruction* should have 2-pixels thick and red-colored borders.
 - iv. The texts of the items in the list inside the article with the id *ingredients* should have a font preference of Arial, Helvetica, or any other sans-serif font.

2. You are given an HTML body shown in Figure 2.

```

<body>
  <style>
    #subtitle-1{
      width: 50px;
      height: 60px;
      margin: 10px;
      margin-top: 20px;
      margin-bottom: 30px;
      border: 3px solid;
      padding: 5px;
      padding-right: 25px;
    }
  </style>
  <p id="subtitle-1">Topics:</p>
  <ul id="list-1">
    <li id="topic-1">What is the Internet</li>
    <li id="topic-2">How to do the Internet</li>
    <li id="topic-3">How to make the Internet</li>
    <li id="topic-4"> Make cool projects:
      <ol id="list-2">
        <li id="hw-1">Make Pies</li>
        <li id="hw-2">Watch Lion King</li>
        <li id="hw-3">Go <em id="em-2">on</em> fast</li>
        <li id="hw-4">Push squares around</li>
        <li id="hw-5">Catch 'em all!</li>
      </ol>
    </li>
  </ul>
</body>

```

Figure 2: HTML code snippet for Question 2

- a) With proper justification, mention an example where it is better to use a POST request instead of a GET request. 5
(CO1)
(PO1)
- b) Describe the style shown in Figure 2 (#subtitle-1) in natural language and draw the labeled diagram of the resultant output. 10
(CO2)
(PO2)
- c) With proper justification, write the IDs of the elements listed in Figure 2 that will be selected by each of the following selectors: 5 × 2
(CO2)
(PO1)
 - i. p
 - ii. ol li
 - iii. li em
 - iv. ul > li
 - v. li li

3. Consider that we have a library management system that allows a book to be added, updated, and deleted from the library dynamically.

Name:

Author:

Genre:

(a) Add book

#SL	Name	Autor	Genre	Action
1	The Art of War	Sun Tzu	Non-fiction	Update Delete
2	The Alchemist	Paulo Coelho	Novel	Update Delete
3	Beloved	Toni Morrison	Novel	Update Delete
4	War and Peace	Leo Tolstoy	Fiction	Update Delete

(b) Display book information with the update and delete action

Figure 3: Different operations related to book for Question 3.

- a) What are the advantages of using a SQL database over text files to store data? 5
(CO1)
(PO1)
 - b) Write the corresponding HTML code based on the Figure 3(a) and validate the following requirements in JavaScript. 10
(CO1)
(PO2)
 - Name: required, a combination of A-Z and a-z.
 - Author: required, at least two words for first and last names.
 - Genre: required, must be in Fiction, Novel, or Non-fiction.
 - c) Analyze Figure 3(b) and write the corresponding PHP code for the update and delete operations. Assume, an id is attached for every book with the update and delete links. 10
(CO2)
(PO2)
4. Two different types of balls are used in Cricket and Football. Each Ball has a property named type, which is initialized in the constructor. Besides, it has one method, draw() that prints whether the ball is used in Cricket or Football based on the type of the ball.

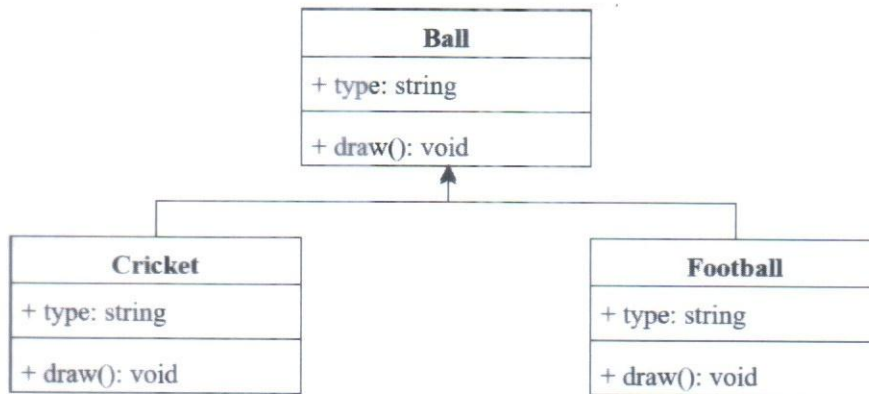


Figure 4: Inheritance example for Question 4.

- a) Describe the relationship between classes and objects with examples. 5
(CO1)
(PO1)
- b) Define inheritance. Implement the above scenario using OOP concept in PHP language. 10
(CO2)
(PO2)
- c) If another class named *child* inherits both the Cricket and Football classes and calls the draw() method, which one will be called? Explain with respect to PHP language. 10
(CO3)
(PO2)

5. Consider the following JSON object given in Figure 5 and answer the subsequent questions.

```
let miniJSON = {
  "waffle" : ["PANCAKE"],
  "pancake" : "waffle",
  "POPTART" : {
    "frosted" : true,
    "flavors" : ["cherry", "strawberry", "jolly rancher"]
  }
};
```

Figure 5: HTML code snippet for Question 5

- a) What is JSON? How to parse it in JavaScript? 5
(CO1)
(PO1)
- b) For each of the following statements, write the value that will be returned (include “ ” around any string values; if any expression will result in an error, write “error”. If any expression will return the value undefined, write “undefined”). 5 × 2
(CO2)
(PO1)
- i. miniJSON[0]
 - ii. miniJSON.pancake
 - iii. miniJSON[‘‘FOO’’]
 - iv. miniJSON[‘‘POPTARTS’’].flavors[1]
 - v. miniJSON[miniJSON[‘‘pancake’’]].length
- c) How can developers use the JSON object from Figure 5 in AJAX to communicate between the client and the server? AJAX stands for Asynchronous JavaScript and XML. 10
(CO2)
(PO1)
6. A course has three properties such as course code, name, and credit. Student A and Student B define the course objects differently. Student A defines all the properties as well as a method named `getDetails(courseCode, name, credit)`. But student B does not implement any method.
- a) Differentiate between `var`, `let`, and `const` in JavaScript with examples. 5
(CO1)
(PO1)
- b) According to the aforementioned scenario, implement both objects (Student A and Student B). 10
(CO2)
(PO1)
- c) How can Student B call the function `getDetails(courseCode, name, credit)` of Student A? Discuss using JavaScript’s built-in `.call()`, `.apply()` and `.bind()` methods. 10
(CO2)
(PO1)

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

Math 4541: Multivariable Calculus and Complex Variables

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) If $f(x, y) = \frac{x-y}{x+y}$, then show that the function does not exist at $(0,0)$. 8
(CO2)
(PO1)
10
- b) If $f(x, y) = \begin{cases} \frac{xy(x^2 - y^2)}{x^2 + y^2} & (x, y) \neq (0,0) \\ 0 & (x, y) = (0,0) \end{cases}$, then test the continuity of the function at $(0,0)$. (CO3)
(PO1)
- c) Evaluate the limit of the multivariable function $\lim_{\substack{x \rightarrow 0 \\ y \rightarrow 0}} (x^2 + y^2) \ln(x^2 + y^2)$. 7
(CO1)
(PO1)
2. a) State and prove the Euler's theorem for multivariable functions. 8
(CO2)
(PO1)
10
- b) If $u = \cos e c^{-1} \sqrt{\frac{x^{1/2} + y^{1/2}}{x^{1/3} + y^{1/3}}}$, then show that $x^2 \frac{\delta^2 u}{\delta x^2} + 2xy \frac{\delta^2 u}{\delta x \delta y} + y^2 \frac{\delta^2 u}{\delta y^2} = \frac{\tan u}{u} \left(\frac{13}{12} + \frac{\tan^2 u}{12} \right)$. (CO2)
(PO1)
- c) Find the directional derivative of the function $f(x, y) = \ln(1 + x^2 + y)$ at the given point $(0,0)$ and in the direction of the vector $V = -\frac{1}{10} \vec{i} - \frac{3}{\sqrt{10}} \vec{j}$. 7
(CO3)
(PO1)
3. a) Find the maximum and minimum values and saddle points of $f(x) = \sin x + \sin y + \sin(x + y)$. 10
(CO2)
(PO1)
- b) Use Lagrange multiplication to show that the maximum value of $U = xyz$, subject to the condition $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2}$ is $\frac{abc}{3\sqrt{3}}$. 7
(CO2)
(PO1)
- c) State the Lagrange's condition to find the maximum and minimum values and define saddle points. If $f(x, y) = x^3 + y^3 - 3x - 12y + 20$, find the maximum and minimum values and critical points. 8
(CO1)
(PO1)
4. a) State the Fubini's theorem over a rectangle region. Evaluate $\iint_R xy dx dy$, where R is quadrant of the circle $x^2 + y^2 = a^2$ when $x \geq 0, y \geq 0$. 10
(CO2)
(PO1)
- b) Evaluate the area of $\iint_R x^2 dA$ where R is the region bounded by the parabolas $y = \frac{16}{x}$ and $x = y$ and $x = 8$. 8
(CO1)
(PO1)

- c) Find the directional derivatives of the function $f(x, y) = \frac{x-y}{x+y}$ at the point $(-1, -2)$ and angle $\theta = \frac{\pi}{2}$ 7
(CO3)
(PO1)
5. a) Use the information $u = x - 2y$ and $v = 2x + y$ to find $\iint_R \frac{x-2y}{2x+y} dA$ where R is the rectangle region enclosed by the line $1 = x - 2y$, $x-2y = 4$ and $1 = 2x + y = 1$, $2x + y = 3$. 10
(CO2)
(PO1)
- b) Prove that $\int_1^2 \int_3^4 (xy + e^y) dy dx = \int_3^4 \int_1^2 (xy + e^y) dx dy$ 7
(CO3)
(PO1)
- c) State Green's theorem. Evaluate $\iint_R x^2 y^2 dx dy$ where the circle $x^2 + y^2 = 1$. 8
(CO1)
(PO1)
6. a) Evaluate the value of the volume integral $\iiint xyz dx dy dz$ over the ellipsoid. 8
(CO2)
(PO1)
- b) Evaluate $\iint_R y dx dy$ where R is the region bounded by the parabolas $y^2 = 4x$ and $x^2 = 4y$. 7
(CO1)
(PO1)
- c) State the Gauss divergence theorem. Evaluate the integral 10
(CO2)
(PO1)
- $$\int_0^1 \int_0^{\sqrt{1-x}} \int_0^{\sqrt{1-x^2-y^2}} xyz dz dy dx.$$

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ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

Math 4543: Numerical Methods

Programmable calculators are not allowed. Do not write anything on the question paper

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin.

1. a) A Trunnion of diameter 12.363" has to be cooled from a room temperature of 80°F before it can be shrink-fit into a steel hub. The equation that gives the diametric contraction (in inches) of the trunnion in dry-ice (boiling point -108°F) is: 8+10
(CO2)
(PO1)
- $$\Delta D = 12.363 \int_{80}^{-108} (-1.2278 \times 10^{-11} T^2 + 6.194 \times 10^{-9} T + 6.015 \times 10^{-6}) dT$$
- Here, a positive ΔD indicates expansion and negative value indicates contraction.
Find ΔD using the 2-segment and 4-segment Simpson's 1/3 rule.
- b) Find the relative approximate error between the result of 2-segment and 4-segment Simpson's 1/3 rule. Analyze the reason for getting such low error. 4+3
(CO3)
(PO2)
2. a) To simplify a model for a diode, it is approximated by a forward bias model consisting of a DC voltage, V_d , and a resistor, R_d . Table 1 contains the voltage vs current data that is collected for a small signal: 12+4
(CO2)
(PO1)

Table 1: Voltage vs Current

V (volts)	I (amps)
0.6	0.01
0.7	0.05
0.8	0.2
0.9	0.7
1.0	2.0
1.1	4.0

Current can be linearly regressed from voltage data as $I = B_0 + B_1 V$, where B_0 and B_1 are the constants of regression. Once B_0 and B_1 are known, the voltage and resistance for the diode can be computed as $V_d = -\frac{B_0}{B_1}$ and $R_d = \frac{1}{B_1}$.

Find the voltage and resistance for the diode.

- b) Explain how relative error can provide more useful insight compared to true error when analyzing the results of a numerical method. 9
(CO3)
(PO2)
3. a) Derive the Trapezoidal rule of Integration from both Calculus and Method of Coefficients. Analyze the geometrical interpretation of these two derivations. 10+5
(CO1)
(PO2)
- b) Taking upto 5 terms of the Taylor series, find the value of $\cos(\pi)$ given that we know $\cos\left(\frac{\pi}{2}\right) = 0$. 10
(CO2)
(PO1)
4. a) Thermistors are used to measure the temperature of bodies. These instruments are based on materials' change in resistance with temperature. To measure temperature, manufacturers provide you with a temperature vs. resistance calibration curve. If you measure resistance, you can find the temperature. Several observations with a thermistor are shown in Table 2. 11
(CO2)
(PO1)

Table 2: Resistance vs Temperature

R (ohm)	T (°C)
1101	25.113
911.3	30.131
636	40.12
451.1	50.128

Determine the temperature for 754.8 ohms using a 1st order Lagrange polynomial.

- b) Using the previous data, determine the result for the same resistance (754.8 ohms) using a 2nd order Lagrange polynomial and find the absolute relative approximate error.
5. a) What is the minimum number of points needed to evaluate the integral for Simpson's 3/8 rule? Derive the Multiple Segment Simpson's 3/8 rule.
- b) Suppose you are given the following data:

Table 3: x vs F(x)

x	0	0.5	1.0	1.5	2.0
F(x)	0	0.19	0.26	0.29	0.31

Find the Forward Difference, Backward Difference and Central Difference approximations of $F'(1)$ using $h = 0.5$.

6. Suppose you are given the following matrix A:

$$A = \begin{bmatrix} 3 & 1 & 2 \\ 1 & 2 & 3 \\ 2 & 3 & 1 \end{bmatrix}$$

- a) Now, answer the following questions:
- i) Analyze the properties of the matrix A to determine whether it can have complex eigenvalues.
- ii) Find the eigenvalues and eigenvectors of the matrix A.
- b) Find the LU Decomposition of the matrix A.

11+3
(CO3)
(PO2)
3+10
(CO2)
(PO1)
3×4
(CO2)
(PO1)

4
(CO1)
(PO2)
12
(CO2)
(PO1)
9
(CO2)
(PO1)

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DURATION: 3 HOURS

FULL MARKS: 150

CSE 4547: Parallel and Distributed Systems

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 6 (Six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

- 1. a) Differentiate between the Global Positioning System and Logical Positioning System. For both systems, give an example scenario where they can be applied. 7
(CO1)
(PO1)
- b) Explain how conflict is avoided when multiple nodes simultaneously try to elect a leader in a ring topology. Provide a suitable example to justify your answer. 8
(CO1)
(PO1)
- c) In Figure 1 below, the nodes S_1, \dots, S_5 are subscribed to some data items. These data items are published by the nodes P_1 and P_2 . Propose a suitable policy that will allow proper coordination in the system. What kind of communication method should be selected for the policy? Justify your answer choice. 10
(CO3)
(PO2)

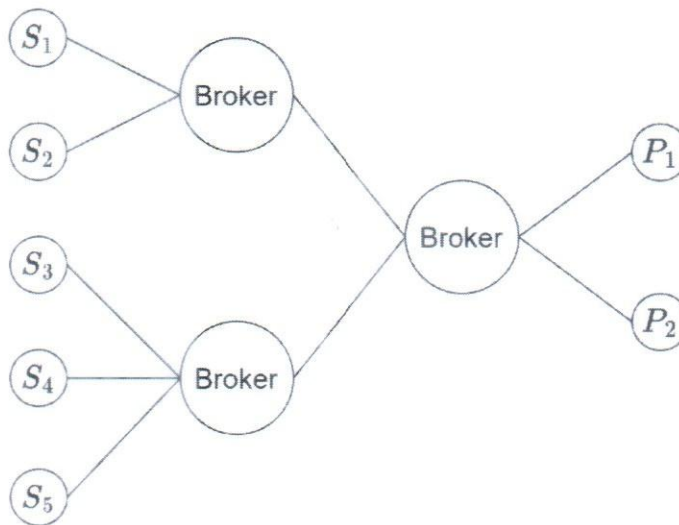


Figure 1: The subscriber-publisher system for Question (1.c)

- 2. a) Explain the four different paradigms for code mobility. 6
(CO1)
(PO1)
- b) Compare between the two different approaches to request dispatching in local area clusters. 8
(CO1)
(PO1)
- c) What is an object server? How does it vary from traditional servers? 5
(CO1)
(PO1)

3. a) Discuss how Wi-Fi-based location services are established to track the position of the nodes in the system. 6
(CO1)
(PO1)
- b) Compare among the centralized, distributed, token-based, and decentralized mutual exclusion algorithms in terms of the number of messages needed to be propagated for a single process to get exclusive access to a shared resource. 9
(CO1)
(PO1)
- c) Figure 2 depicts a wireless network where the letters denote the IDs of the nodes and the numbers denote their capacity. The node *F* initiates an election to select a leader for the network. Show the steps the network will go through during the election process. 10
(CO3)
(PO2)

Assume that whenever a node receives messages from multiple nodes simultaneously, it will always select the node based on the alphabetical order of their IDs. For example, if a node receives messages from B, F and G, it will accept the message from B while discarding the other messages.

Similarly, if multiple nodes have equal capacity, then the node whose ID comes first in the alphabet will be considered for the role of leader.

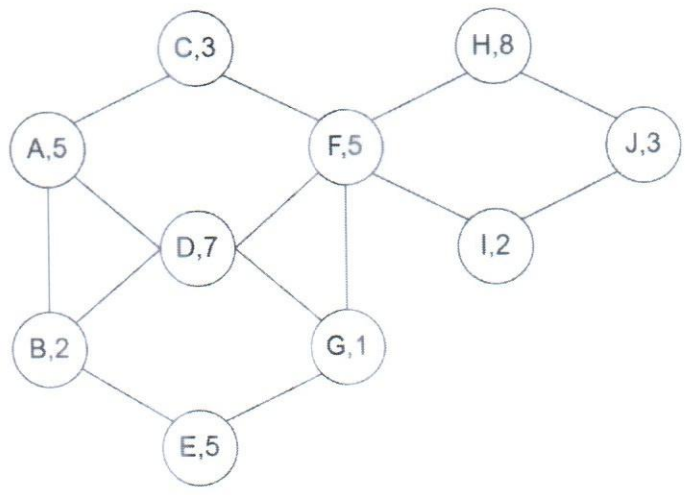


Figure 2: The wireless network for Question (2.c)

4. a) Consider the time-event diagram given in Figure 3. The dots in the diagram represent distinct events and the arrows represent message transmission. A subset of the events is labeled from *a* to *f*. 5+5
(CO3)
(PO2)
- i. Timestamp each event based on the Vector Clock algorithm.
 - ii. For each of the following pairs of events, determine if the happened before relation is ensured:
 - a, b
 - b, d
 - c, e
 - c, f

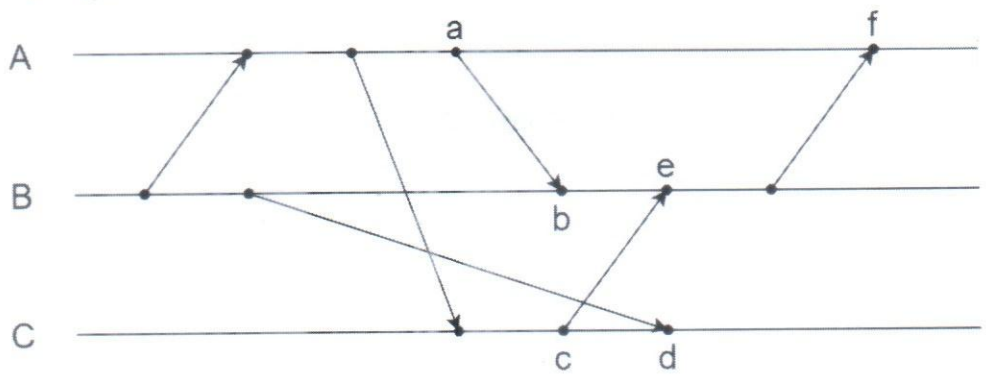


Figure 3: Time-event diagram for Question (3.a)

b) Describe the challenges that are faced when clock synchronization algorithms, developed for traditional distributed systems, are used in wireless networks. Discuss a suitable algorithm for wireless systems that can overcome these challenges. 15
(CO1)
(PO1)

5. a) What are the goals of using wrappers and interceptors in middleware? Explain how they achieve this goal. 7
(CO1)
(PO1)

b) Consider a chord architecture for a P2P system that uses 5-bit keys to map data items to the nodes. The system consists of nodes with the following IDs: {1, 6, 14, 18, 21, 29, 30} where every node is connected to the immediate next node in the system. Additionally, shortcut connection between any two nodes will exist if both have even or odd IDs. A lookup request for the data item with key 20 is made to the node 21. Draw the structure of the system and write down the steps required to service the request. 8
(CO3)
(PO2)

c) You have been assigned the task of designing the architecture of a search engine. The search engine will be a distributed system where the users will have access to a simple application with limited computational capabilities. The bulk of the tasks, such as generating queries from the users' input, ranking the fetched websites using some predefined algorithms, generating the HTML files to be viewed on the user application, will be executed in remote servers. There will be multiple databases that stores the web pages. 10
(CO3)
(PO2)

Suggest an architectural model that is best suited for your task. Discuss how the different components and connectors will be organized in the model.

6. a) Write down the steps for executing the following set of instructions given in Figure 4, using Tomasulo's Algorithm. Assume the latency of the Load unit is 2 clock cycles, Adder is 2 cycles, Multiplier is 10 cycles, and the Divider is 40 cycles. 12
(CO2)
(PO2)

LD	F2	34 + R1	
ADD	F6	F2	F4
MUL	F8	F6	F0
LD	F10	8 + R1	
ADD	F12	F10	F4
DIV	F14	F12	F0

Figure 4: Instruction set for Question (6.a)

b) Explain the Shore's Classification method for classifying different parallel architecture. 8
(CO1)
(PO1)

c) Differentiate between RISC and CISC processors. 5
(CO1)
(PO1)

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SEMESTER FINAL EXAMINATION

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DURATION: 3 HOURS

FULL MARKS: 150

CSE 4549: Simulation and Modeling

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions. Figures in the right margin indicate full marks of questions whereas corresponding CO and PO are written within parentheses. Assume relevant values for any missing data.

1. If a bucket has a small hole at the bottom, the water leaks from the bucket at a constant rate as long as there is water in the bucket. The rate at which water leaks does not depend on the rate at which the water is input to the bucket unless the bucket is empty. Figure 1 depicts a leaky bucket and its effect. (CO1)

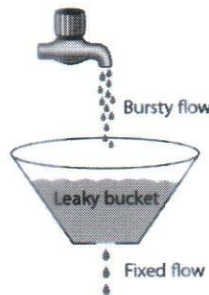


Figure 1: Leaky bucket

A common way to exercise *flow control* in communication networks is to use the *leaky bucket* mechanism. Arriving packets from a process is fed into a queue (i.e., the packet queue) of size K (where K may be infinite). The leaky bucket is implemented as a second queue (i.e., the token-queue) of size B where “tokens” are stored. The token generation mechanism is deterministic with period T , that is, after every T time units, a token is added to the token-queue. When a token finds the token-queue full, it is discarded. If an arriving packet finds a token in the token-queue, the token is removed from the token-queue and the packet is forwarded. In contrast, if an arriving packet finds the token-queue empty, it joins in the packet queue. The head-of-line packet from the packet queue is forwarded when a token arrives by removing the token from the token-queue. The leaky bucket implementation is illustrated in Figure 2. The goal of this flow control mechanism is to decrease the variance of the packet interarrival times of the packets while maintaining the packet queue length (and therefore queuing delays) as minimum as possible.

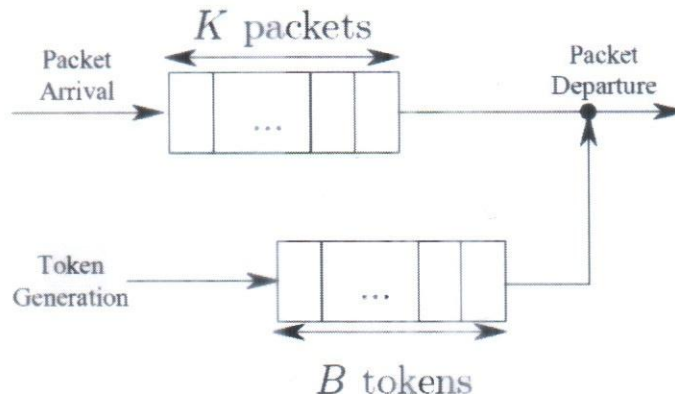


Figure 2: A leaky bucket implementation by two queues

Assume that both the packet-queue and the token-queue are initially empty. The system is investigated for the first n packets. With probability 0.6 the next packet interarrival time is fixed at 0.2 seconds, and with probability 0.4 the next packet interarrival time is exponentially distributed with mean $\frac{1}{\lambda}$.

- a) What are the state variables and output variables for the simulation model? 4
(PO2)
 - b) Mention the set of events for the simulation model. 3
(PO2)
 - c) Write down the state equations and output equations for the simulation model. 7
(PO2)
 - d) Write down the pseudocode of the event handling function that deals with the arrival of packets. 8
(PO3)
 - e) Draw the flow chart of the event handling function that deals with the forwarding of packets. 8
(PO3)
 - f) Write down the algorithm that deals with the token generation process in the simulation. 8
(PO3)
2. a) Develop a random variate generator using the acceptance-rejection method for a random variable with the following distribution: 15
(CO2)
(PO1)

$$f(x) = \begin{cases} 1+x, & -1 \leq x \leq 0 \\ 1-x, & 0 \leq x \leq 1 \\ 0, & \text{otherwise.} \end{cases}$$

Generate 4 random variates using the generator. Following random numbers are available: 0.964, 0.152, 0.759, 0.365, 0.462, 0.785, 0.218, 0.763, 0.568, and 0.631.

- b) Use the inverse transform method to generate random variates with the following distribution function: 10
(CO2)
(PO1)
- $$F(x) = \frac{x^2 + x}{2}, \quad 0 \leq x \leq 1$$
3. Records pertaining to the monthly number of job-related injuries at an underground coal mine were being studied by a federal agency. The values for the past 100 months were as mentioned in Table 1: (CO3)
(PO4)

Table 1: Table for Question 3.

Injuries per Month	Frequency of Occurrence
0	35
1	40
2	13
3	6
4	4
5	1
6	1

- a) Apply the chi-square test to these data to test the hypothesis that the underlying distribution is Poisson. Use the level of significance $\alpha = 0.05$. 10
 - b) Apply the chi-square test to these data to test the hypothesis that the distribution is Poisson with mean 1.0. Again let $\alpha = 0.05$. 10
 - c) What are the differences between parts (a) and (b), and when might each case arise? 5
4. a) Assume you are simulating a computer network to measure the average delay of packets, θ . To estimate θ , you run the simulation 20 times and generated 20 independent mean delays of packets. Assume the values obtained are: 13
(CO4)
(PO4)

102	113	131	107	114
95	133	145	139	117
93	111	124	122	136
141	119	122	151	143

Find the number of additional simulation-runs to be necessary if you want to be 99% certain that your final estimate of θ is correct within ± 0.5 .

- b) You have simulated two systems for 7 replications. The sample means for response time for system 1 are 100, 105, 110, 108, 102, 112 and 98 milliseconds. For system 2 they are 100, 105, 110, 108, 100, 110 and 95 milliseconds. Explain with 95% and/or 90% confidence that one system is better (i.e., has lower response time) than the other system. 12
(CO4)
(PO4)

- 5. Consider the Markovian queueing system shown in Figure 3. Branch labels are birth and death rates. Node labels give the number of customers in the systems. (CO1)
(PO2)

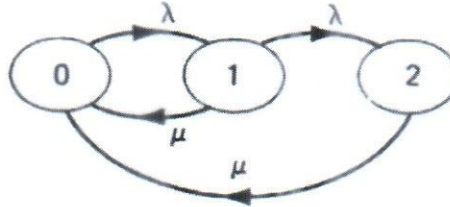


Figure 3: Markovian queueing system.

- a) Solve the queueing system for P_k , the steady-state probability that k customers are in the system. 14
- b) Find the average number of customers in the system. 6
- c) For $\lambda = \mu$, what value do we get for Question 5.a) and 5.b). Try to interpret these results. 5

- 6. Consider an (M, L) inventory system, in which the procurement quantity Q is defined by

$$Q = \begin{cases} M - I, & I < L \\ 0, & I \geq L \end{cases}$$

where I is the level of inventory on hand plus at the end of a month, M is the maximum inventory level, and L is the reorder point. M and L are under management control, so the pair (M, L) is called the inventory policy. The inventory status is checked at the end of each month. Backordering is allowed at a cost of \$4 per item short per month. When an order arrives, it will first be used to relieve the backorder. The delivery lag is given by a uniform distribution on the interval $[0.25, 1.25]$ months. Let the holding cost be \$1 per unit in inventory per month. If an order is placed, its cost is $\$60 + \$5Q$, where \$60 is the ordering cost and \$5 is the cost of each item. The time between demands is exponentially distributed with a mean of $1/15$ month. The sizes of the demands follow a discrete distribution.

There are three sources of randomness (interdemand times, demand sizes, and delivery lags), and three cost components (ordering, holding, and shortage). Suppose you want to compare results for two different inventory policies $(M, L) = (20, 40)$, defined as policy 1, against $(M, L) = (20, 100)$, defined as policy 2. Assume that the policies are compared by replicating the simulations 10 times.

- a) Draw appropriate timing diagram to show that proper synchronization will not be ensured in replication 1, if a single stream of random numbers are used for interdemand times, demand sizes, and delivery lags. 4
- b) Draw appropriate timing diagram to show that proper synchronization will be ensured in replication 1, if 3 separate streams of random numbers are used for interdemand times, demand sizes, and delivery lags. 4
- c) Draw appropriate timing diagram to show that proper synchronization may not be ensured in replication 2 and beyond for at least one of the random sources, even if 3 separate streams of random numbers are used for interdemand times, demand sizes, and delivery lags. 4

Appendix A:

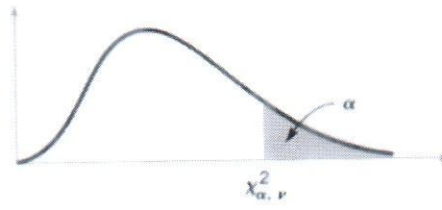


TABLE IV Percentage Points $\chi^2_{\alpha, v}$ of the Chi-Squared Distribution

α v	.995	.990	.975	.950	.900	.500	.100	.050	.025	.010	.005
1	.00+	.00+	.00+	.00+	.02	.45	2.71	3.84	5.02	6.63	7.88
2	.01	.02	.05	.10	.21	1.39	4.61	5.99	7.38	9.21	10.60
3	.07	.11	.22	.35	.58	2.37	6.25	7.81	9.35	11.34	12.84
4	.21	.30	.48	.71	1.06	3.36	7.78	9.49	11.14	13.28	14.86
5	.41	.55	.83	1.15	1.61	4.35	9.24	11.07	12.83	15.09	16.75
6	.68	.87	1.24	1.64	2.20	5.35	10.65	12.59	14.45	16.81	18.55
7	.99	1.24	1.69	2.17	2.83	6.35	12.02	14.07	16.01	18.48	20.28
8	1.34	1.65	2.18	2.73	3.49	7.34	13.36	15.51	17.53	20.09	21.96
9	1.73	2.09	2.70	3.33	4.17	8.34	14.68	16.92	19.02	21.67	23.59
10	2.16	2.56	3.25	3.94	4.87	9.34	15.99	18.31	20.48	23.21	25.19
11	2.60	3.05	3.82	4.57	5.58	10.34	17.28	19.68	21.92	24.72	26.76
12	3.07	3.57	4.40	5.23	6.30	11.34	18.55	21.03	23.34	26.22	28.30
13	3.57	4.11	5.01	5.89	7.04	12.34	19.81	22.36	24.74	27.69	29.82
14	4.07	4.66	5.63	6.57	7.79	13.34	21.06	23.68	26.12	29.14	31.32
15	4.60	5.23	6.27	7.26	8.55	14.34	22.31	25.00	27.49	30.58	32.80
16	5.14	5.81	6.91	7.96	9.31	15.34	23.54	26.30	28.85	32.00	34.27
17	5.70	6.41	7.56	8.67	10.09	16.34	24.77	27.59	30.19	33.41	35.72
18	6.26	7.01	8.23	9.39	10.87	17.34	25.99	28.87	31.53	34.81	37.16
19	6.84	7.63	8.91	10.12	11.65	18.34	27.20	30.14	32.85	36.19	38.58
20	7.43	8.26	9.59	10.85	12.44	19.34	28.41	31.41	34.17	37.57	40.00
21	8.03	8.90	10.28	11.59	13.24	20.34	29.62	32.67	35.48	38.93	41.40
22	8.64	9.54	10.98	12.34	14.04	21.34	30.81	33.92	36.78	40.29	42.80
23	9.26	10.20	11.69	13.09	14.85	22.34	32.01	35.17	38.08	41.64	44.18
24	9.89	10.86	12.40	13.85	15.66	23.34	33.20	36.42	39.36	42.98	45.56
25	10.52	11.52	13.12	14.61	16.47	24.34	34.28	37.65	40.65	44.31	46.93
26	11.16	12.20	13.84	15.38	17.29	25.34	35.56	38.89	41.92	45.64	48.29
27	11.81	12.88	14.57	16.15	18.11	26.34	36.74	40.11	43.19	46.96	49.65
28	12.46	13.57	15.31	16.93	18.94	27.34	37.92	41.34	44.46	48.28	50.99
29	13.12	14.26	16.05	17.71	19.77	28.34	39.09	42.56	45.72	49.59	52.34
30	13.79	14.95	16.79	18.49	20.60	29.34	40.26	43.77	46.98	50.89	53.67
40	20.71	22.16	24.43	26.51	29.05	39.34	51.81	55.76	59.34	63.69	66.77
50	27.99	29.71	32.36	34.76	37.69	49.33	63.17	67.50	71.42	76.15	79.49
60	35.53	37.48	40.48	43.19	46.46	59.33	74.40	79.08	83.30	88.38	91.95
70	43.28	45.44	48.76	51.74	55.33	69.33	85.53	90.53	95.02	100.42	104.22
80	51.17	53.54	57.15	60.39	64.28	79.33	96.58	101.88	106.63	112.33	116.32
90	59.20	61.75	65.65	69.13	73.29	89.33	107.57	113.14	118.14	124.12	128.30
100	67.33	70.06	74.22	77.93	82.36	99.33	118.50	124.34	129.56	135.81	140.17

v = degrees of freedom.

Appendix B:

Critical points $\chi^2_{\nu,\gamma}$ for the chi-square distribution with ν df

$\gamma = P(Y_\nu \leq \chi^2_{\nu,\gamma})$ where Y_ν has a chi-square distribution with ν df; for large ν , use the approximation for $\chi^2_{\nu,\gamma}$ in Sec. 7.4.1

ν	γ						
	0.250	0.500	0.750	0.900	0.950	0.975	0.990
1	0.102	0.455	1.323	2.706	3.841	5.024	6.635
2	0.575	1.386	2.773	4.605	5.991	7.378	9.210
3	1.213	2.366	4.108	6.251	7.815	9.348	11.345
4	1.923	3.357	5.385	7.779	9.488	11.143	13.277
5	2.675	4.351	6.626	9.236	11.070	12.833	15.086
6	3.455	5.348	7.841	10.645	12.592	14.449	16.812
7	4.255	6.346	9.037	12.017	14.067	16.013	18.475
8	5.071	7.344	10.219	13.362	15.507	17.535	20.090
9	5.899	8.343	11.389	14.684	16.919	19.023	21.666
10	6.737	9.342	12.549	15.987	18.307	20.483	23.209
11	7.584	10.341	13.701	17.275	19.675	21.920	24.725
12	8.438	11.340	14.845	18.549	21.026	23.337	26.217
13	9.299	12.340	15.984	19.812	22.362	24.736	27.688
14	10.165	13.339	17.117	21.064	23.685	26.119	29.141
15	11.037	14.339	18.245	22.307	24.996	27.488	30.578
16	11.912	15.338	19.369	23.542	26.296	28.845	32.000
17	12.792	16.338	20.489	24.769	27.587	30.191	33.409
18	13.675	17.338	21.605	25.989	28.869	31.526	34.805
19	14.562	18.338	22.718	27.204	30.144	32.852	36.191
20	15.452	19.337	23.828	28.412	31.410	34.170	37.566
21	16.344	20.337	24.935	29.615	32.671	35.479	38.932
22	17.240	21.337	26.039	30.813	33.924	36.781	40.289
23	18.137	22.337	27.141	32.007	35.172	38.076	41.638
24	19.037	23.337	28.241	33.196	36.415	39.364	42.980
25	19.939	24.337	29.339	34.382	37.652	40.646	44.314
26	20.843	25.336	30.435	35.563	38.885	41.923	45.642
27	21.749	26.336	31.528	36.741	40.113	43.195	46.963
28	22.657	27.336	32.620	37.916	41.337	44.461	48.278
29	23.567	28.336	33.711	39.087	42.557	45.722	49.588
30	24.478	29.336	34.800	40.256	43.773	46.979	50.892
40	33.660	39.335	45.616	51.805	55.758	59.342	63.691
50	42.942	49.335	56.334	63.167	67.505	71.420	76.154
75	66.417	74.334	82.858	91.061	96.217	100.839	106.393
100	90.133	99.334	109.141	118.498	124.342	129.561	135.807

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
 DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
 FULL MARKS: 150

CSE 4551: Computer Graphics and Multimedia Systems

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. A Y -axis aligned infinite cylinder with radius r and origin at point (i, j, k) can be represented by the implicit equation, $H(x, y, z) = (x - i)^2 + (z - k)^2 - r^2 = 0$ in \mathbb{R}^3 space, as shown in Figure 1. A ray in \mathbb{R}^3 space can be represented using the parametric equation, $P(t) = R_0 + t \times R_d$, where R_0 is a point denoting the origin of the ray and R_d is a vector, denoting the direction of the ray. Based on the aforementioned information, answer the following questions.

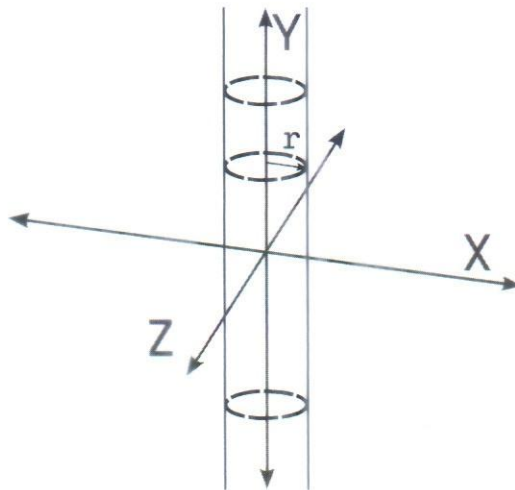


Figure 1: Infinite Cylinder in Y axis for Question 1

- | | |
|--|----------------------|
| a) Formulate and derive a mathematical model to facilitate calculation of ray-cylinder intersection from the aforementioned scenario to integrate them in a ray tracer using <i>vector calculation</i> . You are to formulate vector equations for finding out the value of t at the intersection point and the coordinates of intersection, P . | 12
(CO2)
(PO2) |
| b) Based on the model formulated in the aforementioned question, propose a mathematical equation to calculate the <i>unit hit normal</i> , N at point P . | 7
(CO2)
(PO2) |
| c) Considering that your proposed model is implemented in a ray tracing system, will the calculation be susceptible to shadow acne or self shadowing errors? Give proper justification behind your answer. | 6
(CO1)
(PO1) |
2. Figure 2 represent two different shading models for diffused, Lambertian and Oren-Nayar (with three different roughness, σ values) respectively. As seen from the figure, in the case of the Lambertian model, the outgoing irradiance falls off uniformly based on the angle between incoming light ray and surface normal. However, the same is not true for the Oren-Nayar model, where the roughness parameter can be controlled, which determines the falloff behavior. Hence, the Oren-Nayar model is capable of representing diffused surfaces more accurately than a simple Lambertian model in the case of many materials like concrete, rough ceramic etc. due to certain statistical approaches.

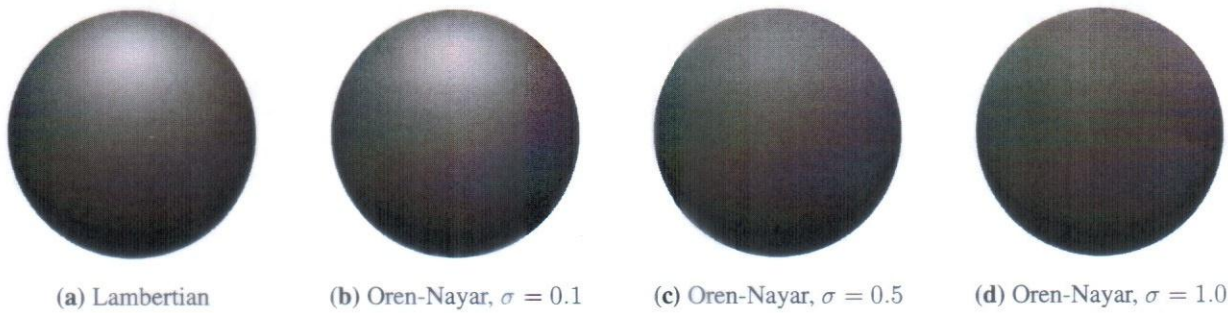
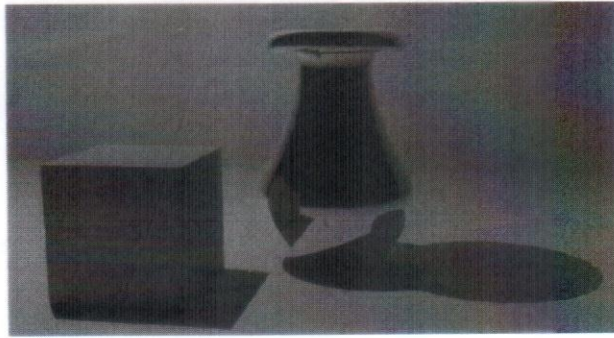


Figure 2: Lambertian and Oren-Nayar shadings of a sphere for Question 2

Based on the aforementioned information and Figure 2, answer the following questions:

- a) Conceptually justify how the Oren-Nayar model is incorporating roughness of the surface into account for diffuse shading, which cannot be done in the case of a simple Lambertian shading. Mathematical derivation is not required for this question. 8
(CO3)
(PO2)
- b) Provided a complete Phong model is expressed as $L_o = [k_a + k_d(n \cdot l) + k_s(v \cdot r)^q] \frac{L_i}{r^2}$, where the symbols have usual meanings, mathematically derive the ambient, diffused and specular components of the model and highlight the BRDFs for each. 10
(CO3)
(PO1)
- c) "The specular component approximation of the Phong model suffers from a major flaw" - Give proper justification behind this statement, and mathematically explain how the Blinn model alleviates such flaw. 7
(CO3)
(PO1)
- 3. a) Mathematically derive and explain the different components of a simple projection matrix for converting a perspective projection into an orthogonal one for GPU based real time graphics. 10
(CO2)
(PO1)
- b) With adequate reasoning, validate why rasterization is a better choice for GPU based real time graphics than ray tracing. 4
(CO4)
(PO2)
- c) Draw an image for a case where Painter's algorithm will fail to resolve depth handling and z-buffer is a must in the case of GPU based real time graphics. 3
(CO3)
(PO2)
- d) Briefly explain the following concepts/terminologies in the case of real time graphics. 4 x 2
(CO1)
(PO1)
 - i Double Buffering
 - ii Frustum Culling
 - iii Z-Fighting
 - iv Model-View-Projection (MVP) Matrix
- 4. a) How are colored images generally represented in digital computers? Explain using appropriate examples. 7
(CO1)
(PO1)
- b) How does a graphical scene benefit from Hierarchical Modeling and Scene Graphs? Explain with the help of appropriate diagrams. 10
(CO1)
(PO1)
- c) The four control points of a cubic Bézier curve in \mathbb{R}^2 space is given as $(0, 0), (0, 1), (1, 0),$ and $(1, 1)$. Draw the cubic control polygon of the curve and the curve itself; then mark the point for $t = 0.25$ on the curve using De Casteljau's algorithm. You do not need to use graph paper for the drawing. 4 + 4
(CO2)
(PO1)

5. Figure 3 depict the output images from two ray tracers, where the ray tracer used in Figure 3(b) contains some extra components which are absent in the one used in Figure 3(a).



(a) Image produced by the first ray tracer



(b) Image produced by the second ray tracer

Figure 3: Images produced by two ray tracers for Question 5

Based on the images, answer the following questions.

- a) Point out two major differences between Figure 3(a) and 3(b) from a ray tracing perspective. 2
(CO3)
(PO2)
 - b) Identify and explain the extra components present in Figure 3(b) which allows the corresponding ray tracer to produce more realistic images than the one in Figure 3(a) using simple mathematical and statistical concepts. 12
(CO3)
(PO2)
 - c) With suitable diagrams, explain why the ray tracer used in Figure 3(b) would require more calculation time than the one in Figure 3(a) and propose one solution conceptually to improve the performance. 5 + 6
(CO4)
(PO1)
6. a) Consider a scenario where you have to perform line clipping against an axes aligned rectangular viewport in a low-end microcontroller that only supports up to basic integer operations natively. If you are to choose between Cohen-Sutherland and Cyrus-Beck Parametric line clipping algorithms, what will be your choice keeping performance in mind? Justify with appropriate reasoning. 10
(CO3)
(PO2)
- b) With an appropriate example, rationalize the reasons behind preferring the followings in almost all particle systems, specially the real time ones. 2 x 5
(CO3)
(PO2)
- i Numerical methods over symbolic manipulation to solve Ordinary Differential Equations (ODEs)
 - ii System of first order ODEs instead of second or higher order ODEs
- c) Briefly explain with examples, how particle systems can bring a graphical scene to life. 5
(CO1)
(PO1)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

CSE 4553: Machine Learning

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

- 1. a) What is Kernel trick? How does the SVM algorithm use Kernel trick for classification. Explain with example. 15 (CO1) (PO1)
b) Suppose that you have a linear SVM binary classifier. Consider a point that is currently classified correctly, and is far away from the decision boundary. If you remove the point from the training set, and re-train the classifier, will the decision boundary change or stay the same? Explain your answer. 10 (CO2) (PO2)
2. a) Suppose you want to predict next words from a given texts depending on the previous words in the sentence based on long-term dependency. Which machine learning model is suitable to predict the text, basic neural network or deep neural network? Explain your answer. 10 (CO2) (PO2)
b) Consider the following configurations: 10 (CO1) (PO1)
- Initial weights, w1 = 0.6, w2 = 0.6
- Learning rate, alpha = 0.5
- Threshold, Th = 1
- For weight update, use stochastic gradient descent method.

Table 1: Logical OR operation

Table with 3 columns: x1, x2, y. Rows: (0,0,0), (0,1,1), (1,0,1), (1,1,1)

Show all the steps of solving logical OR operation given in Table 1 using perceptron learning algorithm for the given configuration. Draw the neural network and show the weight learning process.

- c) Why do you need activation functions in Neural Networks? 5 (CO1) (PO1)
3. a) Mrs. X has lost the gender information of one of her customers, and does not know whether to make a skirt or trouser. The customer whose gender information is missing, only the waist size 28 and hip size 34 is available for that customer. Using K-NN classifier with K=3, find the missing gender information. The training set is given in Table 2. 12 (CO1) (PO1)

Table 2: Training set

Table with 4 columns: S/N, Waist (cm), Hip (cm), Gender. Rows: (1,28,32, Male), (2,33,35, Male), (3,27,33, Female), (4,31,36, Female), (5,28,34, ?)

- b) Suppose you have got the result shown in Table 3 of the confusion matrix of IRIS dataset after applying a clustering algorithm. (CO1) (PO1)

Table 3: Confusion Matrix

		Predicted Class		
		1	2	3
Actual Class	1	46	1	3
	2	3	45	2
	3	0	0	50

- i. Draw the ROC curve from the given confusion matrix. 7
 - ii. Find out the F-Measure. 6
4. a) Write an example scenario where k-means clustering can be used for feature representation. 5 (CO3) (PO1)
- b) Imagine you are dealing with text data. To represent the words you are using word embedding, i.e. representing words as vector of tokens. In word embedding, you will end up with 1000 dimensions. Now, you want to reduce the dimensionality of this high dimensional data such that, similar words should have a similar meaning. In such case, which algorithm are you most likely choose? Explain mathematically how you are going to reduce dimensions. 10 (CO2) (PO2)
- c) Consider the following covariance matrix, 10 (CO1) (PO1)
- $$\begin{bmatrix} 2.0 & 8.0 \\ 8.0 & 0.6 \end{bmatrix}$$
- Find out the first two principal vectors of the matrix.
5. a) Differentiate between bootstrapping and cross-validation. 7 (CO1) (PO1)
- b) Explain the concept of interactive machine learning (iML) with an example application scenario. 10 (CO1) (PO1)
- c) Suppose in a classification problem, you have the probabilities of the three models: M1, M2, M3 shown in Table 4 for five observations of test data set. 8 (CO1) (PO1)

Table 4: Output of three machine learning models

M1	M2	M3	Output
0.70	0.80	0.75	
0.50	0.64	0.80	
0.30	0.20	0.35	
0.49	0.51	0.50	
0.60	0.80	0.60	

What will be the predicted category for these observations if you apply probability threshold greater than or equals to 0.5 for category "1" or less than 0.5 for category "0"? Fill the table with the category you have determined.

6. a) Briefly explain the steps of Convolutional Neural Network with example. 15 (CO1) (PO1)
- b) For the distance matrix given in Table 4, perform the iterations of agglomerative clustering (single linkage) and draw the corresponding Dendrogram. 10 (CO3) (PO1)

Table 4: Distance Matrix

	A	B	C	D
A	0	1	4	5
B		0	2	6
C			0	3
D				0

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4575: Data Structures and Algorithms

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Suppose that, you are given a Doubly Linked List containing integer values sorted in ascending order. The first node of the doubly linked list is referenced by the HEAD pointer but there is no TAIL pointer. Write a function `removeKthNode()` that removes k^{th} node from the end of the doubly linked list. 15
(CO1)
(PO1)

The function prototype is given below.

`Node* removeKthNode (Node* head, int k)`

A testcase is given below:

Input List:

`head --> 1 <--> 2 <--> 3 <--> 4 <--> 5 <--> 6 --> NULL`
`k = 3`

Final Output:

`head --> 1 <--> 2 <--> 3 <--> 5 <--> 6 --> NULL`

While writing the function, consider the following Node class.

```
class Node{
    public:
        int key;
        Node* next;
        Node* prev;
}
```

- b) Find the complexity of the function `removeKthNode()` as in Question 1(a). Provide necessary justification of your answer. 5
(CO1)
(PO1)
- c) Given a Singly Linked List of integers, you want to reverse the list and the reversed list should be stored in another data container such as Stack or Queue. Select the data structure you would use in this case. Justify your answer. 5
(CO1)
(PO1)

2. a) The preorder traversal of a Binary Search Tree (BST) is given below. 10
(CO2)
(PO2)
- 40 20 10 15 25 30 60 50 80 100

Draw the BST and briefly explain the process you followed to build the tree.

- b) Write a function f1 that takes the root of a binary tree as a parameter and returns the sum of the nodes, which are the left child of another node. The root of the tree is not a child of any node. Consider the following class definitions while writing your code. 10
(CO2)
(PO2)

```
class Node {
public:
    int key;
    Node* left;
    Node* right;
};
```

- c) The following sequences show the postorder traversal on a Binary Tree. Which one of them is a Binary Search Tree? 5
(CO2)
(PO1)

Sequence 1 : 10, 15, 20, 35, 50, 40, 30

Sequence 2 : 10, 25, 20, 35, 50, 40, 30

3. a) Consider the following AVL (Balanced Binary) Tree (Figure 1). 5
(CO2)
(PO2)

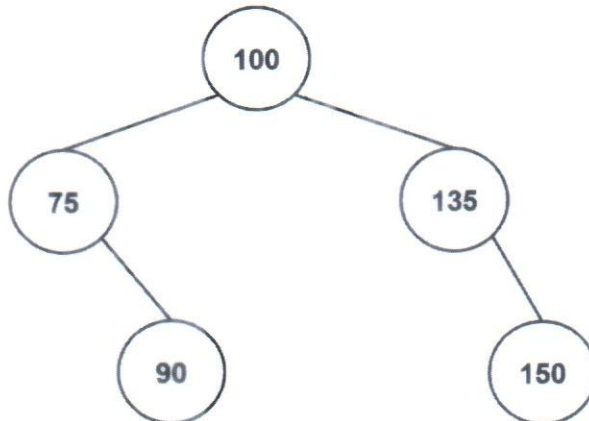


Figure 1: AVL Tree for Question 3

Mark the nodes as LH, EH, or RH, whichever is applicable.

- b) Insert the following numbers on the given tree in Figure 1 and show the resulting AVL tree after each insertion. 15
(CO2)
(PO3)

180, 85, 50, 30, 10

- c) Delete the root of the resulting tree in Question 3(b). Show the resulting AVL Tree. Justify your answer by showing every step during deletion. 5
(CO2)
(PO2)

4. a) Draw the binary min heap that results from inserting 11, 9, 12, 14, 3, 15, 7, 8, 1 in that order into an initially empty binary heap. Show step-by-step formation of the heap. Please indicate your final heap explicitly using a bounding box or rectangle. 10
(CO2)
(PO2)
- b) A file contains the following characters with the frequencies as shown in Table 1. Apply Huffman Coding algorithm for data compression and determine the codeword for each character. 10
(CO2)
(PO2)

Table 1: Frequency of Characters in a file for Question 4.(b)

Character	Frequency
A	10
E	15
I	12
O	3
U	4
S	13
T	1

- c) Find the size of the Huffman encoded file for the Question 4(b). Calculate the percentage of saving disk storage through Huffman coding. 5
(CO4)
(PO2)
5. a) Consider the following directed graph (Figure 2). 10
(CO3)
(PO2)

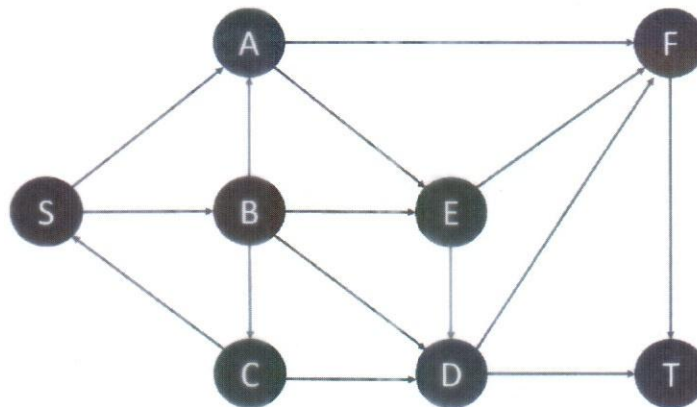


Figure 2: Directed Graph for Question 5.(a)

Find the order of the nodes after applying the DFS algorithm over the same graph as shown in Figure 2. Start the traversal from node S and when visiting multiple nodes are possible, always visit the nodes in alphabetic order. Also, draw the predecessor sub-graph or the DFS Tree.

- b) Critically analyze the performance of BFS algorithm applied over all types of graphs. 5
(CO4)
(PO2)

c) Consider the following weighted undirected graph (Figure 3).

10
(CO3)
(PO2)

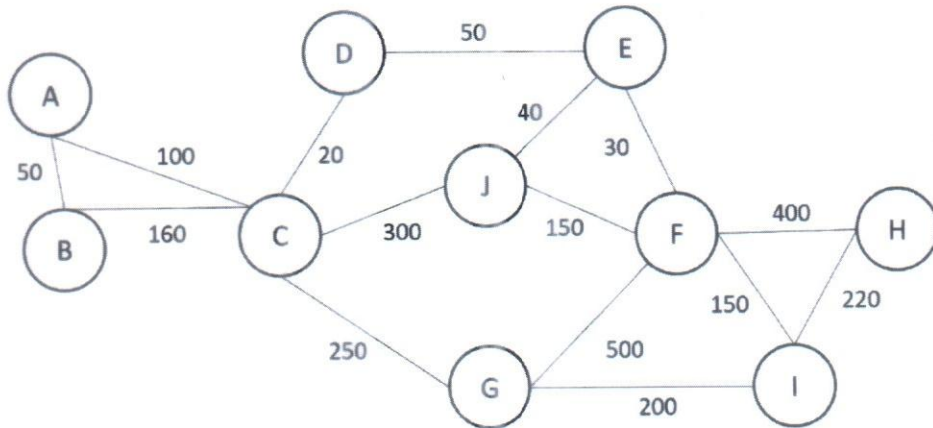


Figure 3: Weighted Undirected Graph for Question 5.(c)

Find the minimum spanning tree using Kruskal's Algorithm. Show the detailed steps of your calculation.

6. a) Consider the following directed graph (Figure 4).

15
(CO3)
(PO2)

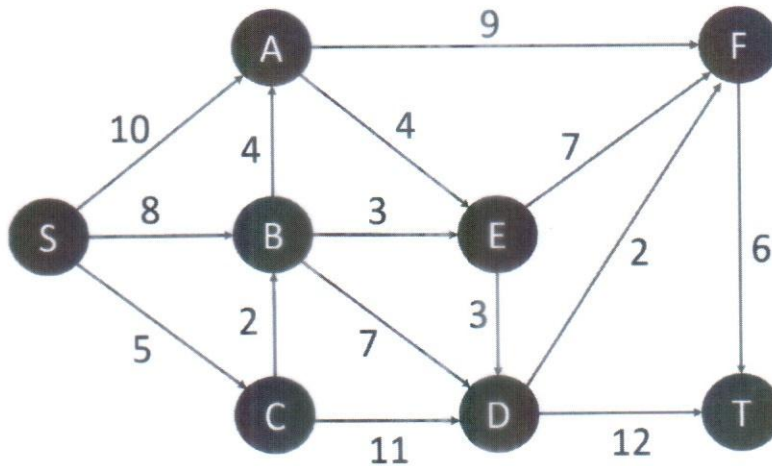


Figure 4: Graph for Question 6.(a)

Find the shortest path from S to all other nodes using Dijkstra's algorithm. Show detailed computation of your answer through a simulation table.

b) Assume that the size of the hash table is 7 and the hash function is $h(k) = k \text{ mod } 7$. Draw the contents of the hash table using both Linear Probing and Quadratic probing for the following sequence of values.

10
(CO3)
(PO2)

10, 35, 18, 17, 26, 42

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4585: Computer Networks

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **3 (three)** questions. Marks of each question and the corresponding CO and PO are written in the right margin with brackets.

- 1. a) Explain why a minimum frame size is required for Ethernet. For example, standard (10Base) Ethernet impose a minimum frame size constraint of 64 bytes. Derive a formula to find the minimum frame size needed for an Ethernet packet where the distance between two ends of an Ethernet LAN is *d*. 4+4
(CO1)
(PO1)
- b) Can RTS-CTS hand-shaking completely eliminate the hidden station problem? If YES, then justify how the RTS-CTS hand-shaking avoids the collision from hidden nodes. If NO, then draw a frame exchange scenario where a collision occurs due to hidden nodes. 7
(CO1)
(PO1)
- c) Demonstrate the looping problem of a transparent bridge with appropriate diagrams. Mention possible solutions to overcome the problem. 10
(CO1)
(PO1)
- 2. a) The Cache-Control Module of ARP package is responsible for maintaining the cache table. Assume that Table 1 is the state of original cache table. Analyze the task of Cache-Control module and draw the cache table for each of the following events. 10
(CO2)
(PO2)
 - i. The ARP output module receives an IP datagram (from the IP layer) in the current instance of time with the destination address 114.5.7.89.
 - ii. Twenty seconds later, the ARP output module receives an IP datagram (from the IP layer) with the destination address 116.1.7.22.
 - iii. Fifteen seconds later, the ARP input module receives an ARP packet with target protocol (IP) address 188.11.8.71.
 - iv. Twenty-five seconds later, the cache-control module updates every entry.

Table 1: Table for question (3.a)

State	Queue	Attempt	Time-Out	Protocol Address	Hardware Address
R	5		900	180.3.6.1	ACAE32457342
P	2	2		129.34.4.8	
P	14	5		201.11.56.7	
R	8		450	114.5.7.89	457342ACAE32
P	12	1		220.55.5.7	
F					
R	9		60	19.1.7.82	4573E3242ACA
P	18	3		188.11.8.71	

- b) What is the purpose of including the IP header and the first 8 bytes of datagram data in the error reporting ICMPv4 messages? Under what circumstances no ICMPv4 error messages is generated? 5
(CO2)
(PO1)
- c) An ISP is granted a block of addresses starting with 130.15.0.0/16. The ISP wants to distribute these blocks to 320 customers as follows: 10
(CO2)

- i. The first group has 64 customers; each needs 256 addresses (PO2)
 - ii. The second group has 128 customers; each needs 128 addresses
 - iii. The first group has 128 customers; each needs 64 addresses
- Design the sub-blocks and show the address allocation and distribution by the ISP. Find out how many addresses are still available after these allocations.

3. a) "Stream control transmission protocol (SCTP) is reliable transport protocol that combines the good features of UDP and TCP" – Justify the statement. 5 (CO2) (PO1)
- b) i. Show the abbreviated form of the following IPv6 address:
0000:00AA:1111:0000:0000:0000:119A:A231 4 (CO2) (PO1)
- ii. Show the original form of the following address:
1234::1:2
- c) Explain the challenges associated with the transition from IPv4 to IPv6, and mention the methods to be used during the transition process. 8 (CO2) (PO2)

OR

- What is IP address space depletion? Briefly explain different measures to handle IP address depletion. 8 (CO2) (PO2)
- d) Compare IPv4 options and IPv6 extension headers. Mention the benefit of dropping the checksum field from IPv6 header. Does it introduce any potential danger of forwarding erroneous packets by IPv6? Explain. 8 (CO2) (PO2)

4. a) Consider the network shown in Figure 1 where each node initially knows the costs to each of its neighbors. Consider the distance-vector algorithm and show the distance vector/table entries at node X that is shared with its neighbors. How does the scenario change if we use link state algorithm instead of distance vector algorithm? 7 (CO3) (PO2)

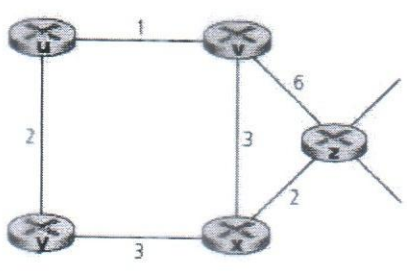


Figure 1: Network for question (4.a)

- b) Consider the network given in the Figure 2. With the indicated link costs, use Dijkstra's shortest-path algorithm used in link state routing to compute the shortest path from V to all network nodes. Prepare the routing table for node V. 12 (CO3) (PO2)

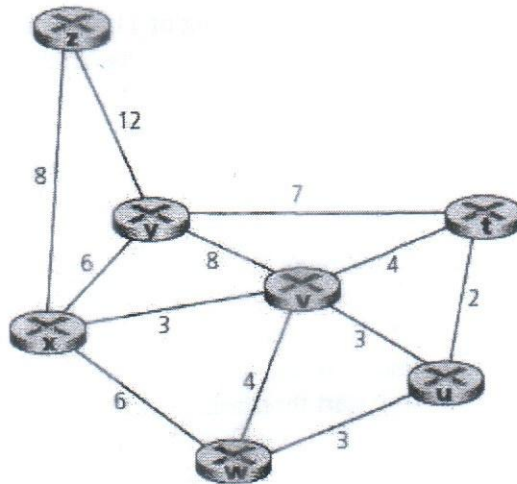


Figure 2: Network for question (4.b)

- c) Differentiate between distance-vector routing and path-vector routing. Mention some of the methods to eliminate the C2I (Counting to Infinity) problem of distance-vector routing. 6
(CO3)
(PO2)
5. a) Neatly sketch the state transition diagram of TCP connection establishment and connection termination. TCP opens a connection using an initial sequence number (ISN) of 23. The other party opens the connection with an ISN of 17. 10
(CO2)
(PO2)
- i. Show the three TCP segments during the three-way handshaking connection establishment.
 - ii. Show the contents of the segments during the connection termination using four-way handshaking with half-close.
- Use two timelines for each side to show the states and the relative duration-of the client and the server.
- OR
- TCP uses sliding window technique for flow control. The sender has sent bytes upto 202 and the receiver has sent an acknowledgment number of 200 with an rwnd of 12 bytes (assume the cwnd is 20). Depict the current window. 10
(CO2)
(PO2)
- After some time the sender has received an acknowledgment value of 204 and an rwnd of 6. Draw the new window. Is there any problem with the new window? If yes, explain the problem with the possible solution.
- b) The following is a dump of a TCP header in hexadecimal format. 5
(CO2)
(PO2)
- (05320017 00000001 00000000 500207FF 00000000)₁₆
- i. What is the destination port number?
 - ii. What is the acknowledgment number?
 - iii. What is the length of the header?
 - iv. What is the type of the segment?
 - v. What is the window size?
- c) With the aid of necessary equations and diagrams explain how the value of Retransmission Time-Out (RTO) is calculated for the Retransmission timer. Your answer should include a scenario incorporating the Karn's algorithm. 10
(CO2)
(PO2)
6. a) SCTP uses a four-way handshaking for an association establishment, whereas TCP uses a three-way handshaking for a connection establishment. What are the improvements of SCTP association establishment with the cost of an extra message passing? An SCTP client opens an association using an initial tag of 2200, an initial TSN of 11111, and a window size of 6
(CO2)
(PO2)

30000. The server responds with an initial tag of 1100, an initial TSN of 250, and a window size of 15000. Show the time-line diagram of the association establishment.

- b) Explain the following concepts with respect to SCTP:
- i. Multihoming
 - ii. Verification Tag
 - iii. HEARTBEAT chunk
- c) How does congestion control differ from flow control and error control? A TCP source sends segments of equal size and maintains the sequence number for each segment (i.e., the TCP protocol is segment-oriented instead of byte-oriented). Assume that the sequence number of the first data segment is 125. The size of the receiver window (rwnd) is always larger than the congestion window (cwnd). For the first data segment, assume that the value of the cwnd is 1, and the value of the slow start threshold (sssth) is 65000. Draw a timing diagram for the transmission of segments, where the y-axis shows the time, and two parallel lines in the y-axis represent the events (sending and receiving of data and ACK segments, cwnd values, etc.) at the source and destination TCP. Assume that the source always tries to send as many data segments as it is allowed. Consider the following while giving your answer:
- The successful transmission of at least 30 segments.
 - Seventh (17th) Segment is lost and the source identifies this by triple duplicate acknowledgments.
 - Fourteenth (24th) Segment is lost (assume subsequent segments are also lost) and the source identifies this by a timeout.
 - At the left side of the source TCP timeline, show the value of cwnd and ssth, whenever they are updated.
 - Identify the slow start, congestion avoidance, and congestion detection region in the source TCP timeline.

9
(CO2)
(PO2)
10
(CO2)
(PO2)

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

SWE 4701: Software Metrics and Process

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Consider the following items: 6+3
(CO1)
(PO1)
- Defect detection efficiency
 - Size of test code
 - Test coverage
 - Requirements reliability
 - Time for implementation
 - System spoilage
 - Developer productivity
 - Module stability
 - Fault count
 - System uptime
- i. Which of the items above belong to Direct and Derived measures.
- ii. Write the formula to compute Test coverage and System spoilage for a software.
- b) CTO of NinjaTech Software Ltd wants to perform Integration testing, UI testing, and Penetration testing in his/her company. S/he hired some experienced (average 4 years) testers to perform these testing. Before implementing these testing methods the CTO wants to know the effectiveness of these testing by conducting a formal experiment. 8
(CO4)
(PO3)
- Develop the factorial design of the experiment by considering Crossing and Nesting of factors.
- c) What is Retrospective study? Briefly discuss different types of threats to validity in Empirical Study. 8
(CO4)
(PO1)
2. a) What is Goal Question Indicator Metrics (GQIM) Framework? Briefly describe each steps to apply the framework. 12
(CO3)
(PO1)
- b) An Inventory System has 6 screens, 2 reports, and 1 external component. It uses 6 data tables to perform its functionality. Table 1 contains the number of views for screens and reports. 6+2
(CO4)
(PO2)

Table 1: Inventory System Data for Question 2.b)

Screens	Number of views	Screens	Number of views	Reports	Number of views
1 st Screen	2	2 nd Screen	5	1 st Report	1
3 rd Screen	8	4 th Screen	1	1 st Report	3
5 th Screen	3	6 th Screen	6		

If High experienced developers with the productivity value 25 are used to build the system:

- i. Estimate the effort to build the system by calculating Object Point.
- ii. Estimate the effort to build the system if 22% of the system can be reused.

- c) How to use Use-Cases of a software to measure Use Case Point? 5
(CO2)
(PO1)
3. a) Why Object Oriented metrics are different from the conventional software metrics? 7
(CO1)
(PO1)
- b) "A good design should exhibit high cohesion and low coupling." design a Class Diagram to discuss this assertion in terms of the metrics *Coupling Between Object (CBO)* and *Lack of Cohesion Measure (LCOM)*. 8
(CO2)
(PO2)
- c) Figure 1 represents a Component-based System (CBS) design where A, B, and C are three components and 1-9 are elements of those components. 5+5
(CO2)
(PO2)

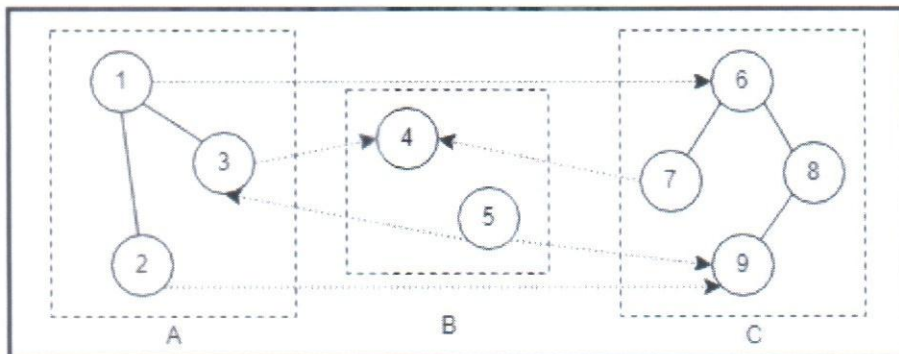


Figure 1: Component-based Software Design

- i. Calculate the *Cohesion* of each of the components and the overall system.
- ii. Calculate the "Instability" of the three packages A, B, and C where each of the constituent "elements" (for example, 1, 2, etc.) represent "classes" within the packages and the "directed edges" represent the corresponding "relationship" among the classes following Object Oriented Programming (OOP).
4. a) What is tree impurity? Calculate tree impurity for module C in Figure 1. 6
(CO2)
(PO1)
- b) Consider the novel Structural Complexity measure as proposed in Equations 1, and 2. Equation 1 computes the *complexity of a module* and Equation 2 computes the *total complexity* of the system. What properties of Structural Complexity do the proposed measure satisfy? 8
(CO2)
(PO2)
- $$C_{new} = length_m \times (fanin_m - 0.5 fanout_m) \tag{1}$$
- $$C_{newSys} = \sum_{i=1}^n length_i \times \left(\sum_{i=1}^n fanin_i - 0.5 \sum_{i=1}^n fanout_i \right) \tag{2}$$
- c) What is the trade-off between *Cyclomatic Complexity* and *Data Structure Complexity*? 5
(CO1)
(PO1)
- d) What is *Usability*? How can we compute the *usability* of a mobile application? 6
(CO1)
(PO1)
5. a) Figure 2 represents a software lifetime, where the X-axis denotes time in "hour" and the Y-axis denotes the operation state of the software based on the following values:
- 1 - Operating normally
 - 0 - Under repair
- 5+4
(CO2)
(PO2)

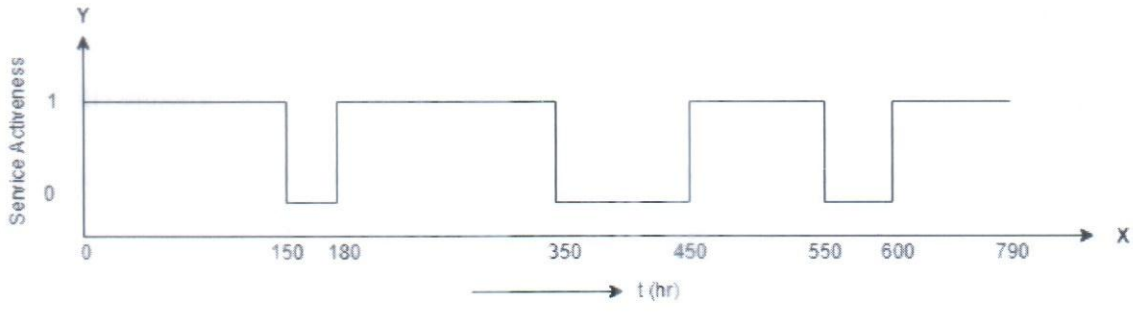


Figure 2: A software lifetime.

- i. Calculate the *Availability* of the software in Figure 2, and interpret the result while the availability requirement is 82%.
- ii. Measure *Mean Time To Repair (MTTR)* of the software in Figure 2. If repair time requirement is at most 65 hours, interpret the obtained result.

- b) What is *Reliability Model*? Explain *Bathtub Curve* for software reliability with figure. 6
(CO1)
(PO1)
- c) A software company develops software components. In a normal condition, a component operates 900 hours without encountering any failure. In a study, 8 components were tested and it was found that 4 components failed at 450, 550, 700, 300 hours. 5+5
(CO2)
(PO2)
 - i. If components failure rate is constant and follows the exponential distribution, what is the reliability of the component at 750 hours? Interpret the obtained result.
 - ii. If components failure rate follows the Weibull distribution with a shape parameter is 2, what is the reliability of the component at 800 hours? Interpret the obtained result.

- 6. a) Consider the main function of Listing 1 and answer question 6.a. The code checks whether a given number is prime or not. [Use appendices if necessary] 7+6
+3+6

Listing 1: Code Snippet for Question 6.a

```

1 #include <stdio.h>
2 int main() {
3     int n, i, flag = 0;
4     printf("Enter a positive integer: ");
5     scanf("%d", &n);
6
7     if (n == 0 || n == 1) flag = 1;
8     for (i = 2; i <= n / 2; ++i) {
9         if (n % i == 0) {
10            flag = 1;
11            break;
12        }
13    }
14
15    if (flag == 0)
16        printf("%d is a prime number.", n);
17    else printf("%d is not a prime number.", n);
18
19    return 0;
20 }

```

+3
(CO2)
(PO2)

- i. Design a control flowgraph
- ii. Draw decomposition tree and calculate depth of Nesting.
- iii. Consider a D-structured graph only allows $\{P_1, D_0, D_1\}$ as Basic Control Structure (BCS). Justify whether the program is D-structured program or not.
- iv. Calculate the minimum number of test cases required for statement coverage by considering the decomposition tree.
- v. Identify independent paths to cover all the branches of the flowgraph.

Appendices

Sequencing Function

Test Strategy	$F_1; \dots F_n$
All-path coverage	$\prod_{i=1}^n \mu(F_i)$
Branch coverage	$max(\mu(F_1), \dots, \mu(F_n))$
Statement coverage	$max(\mu(F_1), \dots, \mu(F_n))$

Nesting Function

Test Strategy	$D_1(F_1, F_2)$	$C_n(F_1, \dots, F_n)$	$D_0(F)$	$D_2(F)$
All-path coverage	$\mu(F_1) + \mu(F_2)$	$\sum_{i=1}^n \mu(F_i)$	$\mu(F) + 1$	-
Branch coverage	$\mu(F_1) + \mu(F_2)$	$\sum_{i=1}^n \mu(F_i)$	$\mu(F) + 1$	1
Statement coverage	$\mu(F_1) + \mu(F_2)$	$\sum_{i=1}^n \mu(F_i)$	$\mu(F)$	1

Test Strategy	$D_3(F)$	$D_4(F_1, F_2)$	$L_2(F_1, F_2)$
All-path coverage	-	-	-
Branch coverage	1	1	2
Statement coverage	1	1	1

Measurement Values for Primes

Test Strategy	P_1	D_0	D_1	C_n	D_2	D_3	D_4	L_2
All-path coverage	1	2	2	n	-	-	-	-
Branch coverage	1	2	2	n	1	1	1	2
Statement coverage	1	1	2	n	1	1	1	1

Complexity of Screen and Report views' for Object Point

Screen number of views	Report number of views	Number and source of data tables		
		Total < 4, < 2 servers, < 2 clients	Total < 8, 2-3 servers, 3-5 clients	Total 8+, > 3 servers, > 5 clients
< 3	0-1	Simple	Simple	Medium
3-7	2-3	Simple	Medium	Difficult
8+	4+	Medium	Difficult	Difficult

Complexity Score for Object Point

Object Type	Simple	Medium	Difficult
Screen	1	2	3
Report	2	5	8
3GL component	-	-	10

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

CSE 4703: Theory of Computing

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin. Assume if any value is missing. Symbols have their usual meaning.

1. a) With proper justification, determine if each of the following assertion is correct or incorrect. 2 × 5
(CO1)
(PO1)
- i. It is known that the set $S = \{0^n \mid n \text{ is a prime number}\}$ is not regular. But its complement is regular.
 - ii. If a language is accepted by an NFA, then it is clearly context-free.
 - iii. You cannot build a DFA to recognize $\{0^{500}1^{10000} \cup 1^{10000}0^{100}\}$
 - iv. All languages are decidable.
 - v. From a computability perspective, every multi-tape Turing machine has an equivalent single-tape TM.

- b) Prove that if L, M and N are any languages, then $L(M + N) = LM + LN$. 5
(CO1)
(PO1)

- c) Design a Finite State Machine (FSM) that accepts the language L over the alphabet $\Sigma = \{0, 1\}$, where 10
(CO1)
(PO2)

$L = \{w \mid w \text{ contains at least one 1 and an even number of 0s follow the last 1}\}$.

2. a) Consider the NFA state diagram given in Figure 1 and answer the following questions. 2+2+4
(CO2)
(PO2)
- i. Does this NFA accept the string 001001 ?
 - ii. What about the string $ba0011$?
 - iii. Determine the regular expression that evaluates the same language that this NFA recognizes.

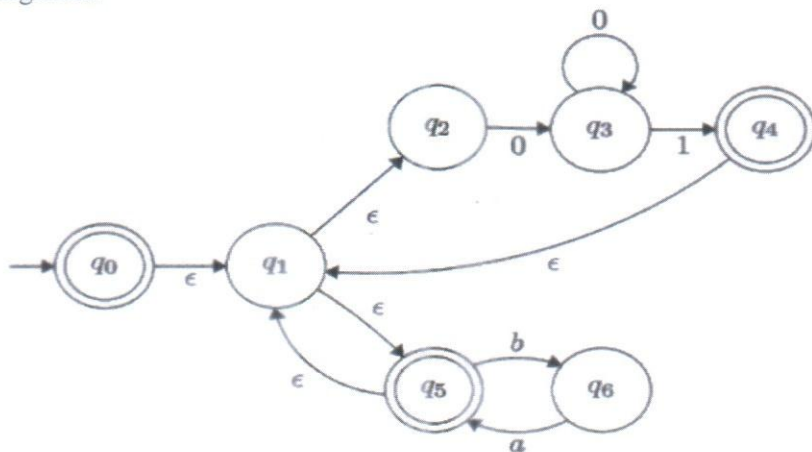


Figure 1: NFA diagram for question 2. (a)

- b) Assume that $N1$ is a Nondeterministic Finite State Machine (NFA), where 9
 $N1 = (Q_1, \Sigma, \delta_1, q_1, F_1)$ recognize L_1 . Construct an NFA, $N = (Q, \Sigma, \delta, q_0, F)$ that (CO2)
 recognizes L_1^* . (PO2)
- c) Consider the language, $L = \{1^n 2^{n+m} 1^m, m, n \geq 0\}$. Prove that, L is context-free language 8
 by creating a context-free grammar that generates L over the alphabet $\Sigma = \{1, 2\}$. (CO2)
(PO2)
3. a) What is Chomsky normal form of a grammar? Convert the following context free grammar 2+8
 (CFG) into Chomsky normal form. (CO1)
(PO1)

$$S \rightarrow ASA \mid aB$$

$$A \rightarrow B \mid S$$

$$B \rightarrow b \mid \epsilon$$

- b) Cocke-Younger-Kasami (CYK) algorithm is a membership algorithm of context free 10
 grammar. Determine if the string, $w = abab$ is the member of language generated by (CO2)
 grammar given below using CYK algorithm. (PO2)

$$S \rightarrow AB \mid BC$$

$$A \rightarrow BA \mid a$$

$$B \rightarrow CC \mid b$$

$$C \rightarrow AB \mid a$$

- c) Show the relationship among the classes of regular, context-free, decidable, turing- 5
 recognizable languages. (CO2)
(PO2)
4. a) Construct the Push-down Automata (PDA) that recognizes the *language, $L =$ 8
 $\{wcw^R \mid \text{where } w = (a + b)^* \text{ over the alphabet } \Sigma \{a, b, c\} \text{ and } w^R \text{ is reverse of } w.\}$ (CO2)
(PO2)
- b) The Turing Machine (TM) contains an infinite length of tape that stores the input string during 9
 TM simulation. We can determine the right end of the input string by scanning the blank (CO2)
 symbol (B) at the right end of the input, but it is difficult to recognize the left end of the tape, (PO2)
 shown in Figure 2. However, we can recognize the left end of the tape by inserting a special
 symbol (\$) on the left end and shifting the input over one cell to the right.

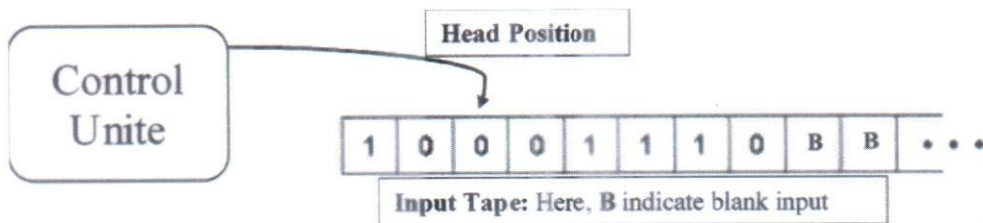


Figure 2: Turing Machine

Now your task is to design a detail state diagram for Turing machine that inserts a special symbol (\$) on the left-end and shifts the input over one cell to the right.

- c) Give the formal definition of a Turing machine (TM). Based on your formal definition answer the following questions, and explain your reasoning. 2 × 4
(CO1)
(PO1)
 - i. Can a Turing machine ever write the blank symbol, \sqcup on its tape?
 - ii. Can the tape alphabet, Γ be the same as the input alphabet, Σ ?
 - iii. Can a Turing machine's head ever be in the same location in two successive steps?
 - iv. Can a Turing machine contain just a single state?

- 5. a) A Turing machine with *stay put* instead of *left* is similar to an ordinary Turing machine, but the transition function has the form as follows: 6+2
(CO2)
(PO2)

$$\delta: Q \times \tau = Q \times \tau \times \{Right, Stay\}$$

At each point, the machine can move its head *Right*, or let it *Stay* in the same position.

- i. Show that this Turing machine variant is not equivalent to the usual version.
- ii. What class of languages do these machines recognize?

- b) Language L_1 and L_2 are decidable languages. Show that $L_1 \circ L_2$ is also decidable language by constructing a Turing Machine, M that accept $L_1 \circ L_2$. Write a high-level description of a Turing machine that decides. 9
(CO3)
(PO2)

- c) Show that A_{REG} is decidable language, where 8
(CO3)
(PO2)

$$A_{REG} = \{ \langle R, w \rangle \mid R \text{ is a regular expression that generates string } w \}.$$

- 6. a) Show that a language is Turing-recognizable if and only if some enumerator enumerates it. 9
(CO2)
(PO2)

- b) Show that A is decidable language, where 9
(CO3)
(PO2)

$$A = \{ \langle M \rangle \mid M \text{ is a DFA and doesn't accept any string containing an odd number of 1s} \}$$

- c) What does Church-Turing thesis claim? Differentiate between enumerator and Turing Machine. 3+4
(CO1)
(PO1)

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

CSE 4711: Artificial Intelligence

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets. The symbols have their usual meanings.

1. Consider that a badly-designed website called 'BeFake' uses a simple encryption software to encrypt the passwords of its users. During registration, BeFake takes the password string as input, encrypts it using a hash function provided by the software, and stores it in a file. If any registered user tries to log in, their input password is again encrypted and checked against the stored password. Unfortunately, you use the same username and password on multiple sites, including BeFake.

Mallory, a malicious hacker and your archenemy, hacked into the server of BeFake and got hold of the encryption software and the files containing the encrypted passwords. She knows your username but does not know the password. However, she knows that your password consists of a combination involving at most three different English letters, 'P', 'Q', and 'R'. She also knows that some letters are more likely to occur than others. So she encodes this by setting, $cost(P) = 1$, $cost(Q) = 2$, and $cost(R) = 3$.

To find your password, Mallory will generate different strings consisting of those letters, provide it to the software to generate the encrypted string, and compare it with the stored password until the first match. She will use search algorithms, specifically, Breadth-First Search (BFS), Depth-First Search (DFS), and Uniform Cost Search (UCS), to generate the passwords in lexicographic order. Assume that all ties are broken in lexicographic order.

- a) Show how Mallory would formulate the search problem by identifying the states, start state, successor function, and goal test. 5
(CO1)
(PO2)
- b) Assume that the search algorithms, used by Mallory, predict up to 6 letter combinations. Due to collision, the encryption software generates the same hash value for the strings: PPRR, RQQPPP, RRR, and QQQQ. 20
(CO3)
(PO2)
Assume that your password is RQQPPP. With a brief explanation, assess how doomed you are.

2. The St. Petersburg paradox, proposed by Nicolas Bernoulli in 1713, describes the following game: a fair coin is tossed repeatedly by the player until it comes up as tails. If the first tails appears on the n^{th} toss, the player wins 2^n dollars.

- a) Given infinite resources, show that the expected monetary value of the lottery is infinite. 6
(CO1)
(PO1)
- b) Assume that Elon Musk (whose net worth is 182.6 billion US Dollars) offers to cover the lottery payout. Show how that affects the expected monetary value of the lottery. 6
(CO3)
(PO2)
- c) Nicolas's cousin, Daniel Bernoulli, resolved the paradox in 1738 by suggesting that the utility of money is measured on a logarithmic scale. For example, $U(S_m) = \log_2(m)$, where S_m is the state of having \$ m and $m > 0$. 8
(CO3)
(PO2)

Under these circumstances, determine the maximum amount of money a rational player would pay to play the game. Assume that the player has to give up all of his/her money. Use $\sum_{n=1}^{\infty} \frac{n}{2^n} = 2$, if necessary.

3. The game tree for a game between Alice and Bob is shown in Figure 1. The players make choices to maximize their utility functions which are known to the players beforehand. Alice can move Left, Right, or Straight, whereas Bob can move Left or Right. Alice moves first.

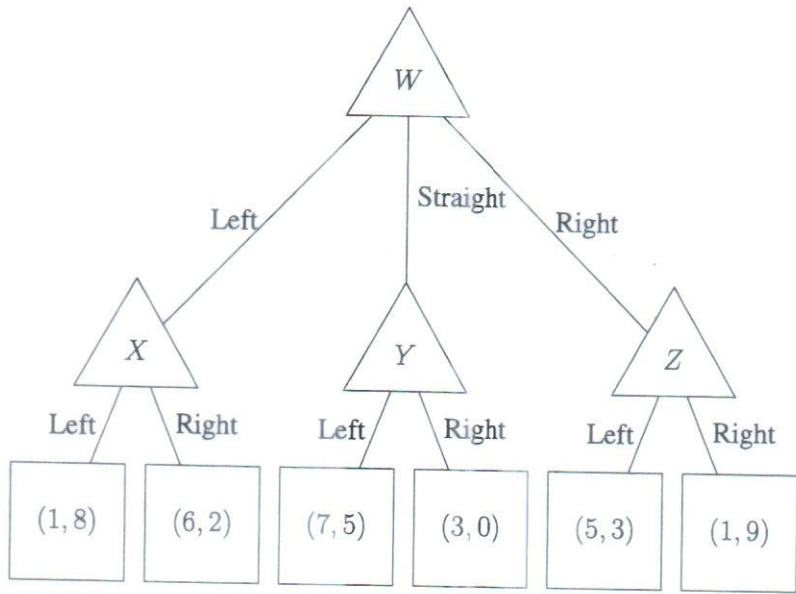


Figure 1: Game Tree for Question 3

Let (x, y) denote the pair of values in the terminal nodes.

a) Let the utility functions for Alice and Bob be $U_A(x, y) = x$ and $U_B(x, y) = x - y$ respectively.

i. Determine the optimal action for Alice in this scenario.

5
(CO3)
(PO2)

ii. Identify the nodes that can be pruned considering the branches are explored from left to right.

1
(CO1)
(PO1)

b) Assume that Bob's utility function changes based on his mood. Table 1 denotes the marginal probability distribution associated with Bob's mood and Table 2 denotes the conditional probability distribution associated with Bob's utility function conditioned on his mood.

Table 1: Mood distribution

M	P
Happy	0.60
Sad	0.40

Table 2: Utility distribution

U_B	$P(U_B M = \text{Happy})$	$P(U_B M = \text{Sad})$
$-x$	0.45	0.30
$x - y$	0.25	0.45
$x^2 + y^2$	0.30	0.25

i. Calculate the likelihood of each utility functions for Bob.

3×2
(CO3)
(PO2)

ii. Determine the optimal action for Alice in this scenario.

13
(CO3)
(PO2)

4. Consider that a game of Pacman is being played on the grid shown in Figure 2.

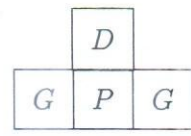


Figure 2: Pacman Grid for Question 4

Here, P indicates the position of Pacman, G indicates the position of the ghosts, and D indicates the position of a food dot. For simplicity, the ghosts remain stationary throughout the game.

To determine the policy for playing the game, our feature-based Q-learning agent, Pacman, uses two features, F_g and F_d defined as follows:

$$F_g(s, a) = F_1(s) + F_2(s, a) + F_3(s, a)$$

$$F_d(s, a) = F_4(s) + 2 \times F_5(s, a)$$

where

- $F_1(s)$ = number of ghosts within 1 step of state s
- $F_2(s, a)$ = number of ghosts Pacman touches after taking action a from state s
- $F_3(s, a)$ = number of ghosts within 1 step of the state Pacman ends up in after taking action a
- $F_4(s)$ = number of food dots within 1 step of state s
- $F_5(s, a)$ = number of food dots eaten after taking action a from state s

After a few episodes of Q-learning, the weights are $w_g = -10$ and $w_d = 100$. The discount factor, $\gamma = 0.5$ and learning rate, $\alpha = 0.5$. The action space of Pacman is $\{left, right, up, down, stay\}$. Pacman can take any actions from a state given it does not go beyond the grid.

- | | | |
|-------|--|-------------------------|
| a) | Considering the actions, a that are available from the current position, s of Pacman: | 12+6 |
| | i. Calculate $F_g(s, a)$ and $F_d(s, a)$. | (CO1) |
| | ii. Calculate $\hat{Q}(s, a)$. | (PO1) |
| b) | Determine the optimal policy for Pacman from its current position following the $\hat{Q}(s, a)$ values calculated. Argue on how good the policy is considering the alternatives. | 2 + 3
(CO3)
(PO2) |
| c) | From its current position, s , Pacman moves up to go to the cell, s' containing the food dot and eats it. We observe a reward, $R(s, a, s') = 250$. | 4 + 3
(CO1) |
| | Considering the actions, a' that are available from s' : | (PO1) |
| | i. Calculate $Q(s, up)$. | |
| | ii. Update w_g and w_d . | |
| 5. a) | Consider the following statements: | 12 |
| | • Surely computers cannot be intelligent - they can do only what their programmers tell them. | (CO3) |
| | • Surely humans cannot be intelligent - they can do only what their genes tell them. | (PO2) |
| | For each of the statements, is the latter clause true? And does it imply the former? Provide brief arguments. | |
| b) | Sometimes Markov Decision Processes (MDP) are formulated with a reward function $R(s, a)$ that depends on the action taken, or $R(s, a, s')$ that also depends on the outcome state. | 5
(CO2) |
| | Modify the Bellman Equation to determine the value of a state based on these formulations. | (PO2) |
| c) | Suppose that we define the value of a state to be the maximum (as opposed to summation) reward obtained from its future states. | 2 + 6
(CO1) |
| | Does this result in stationary preferences? If yes, justify your position. If not, provide a counterexample. | (PO1) |

6. Consider that we have placed a robot in an unknown environment. It can perceive its current state, s_t , and execute an action, a_t . Upon executing the action, the robot can move to another state, s_{t+1} (possibly the same as before), and get an instant reward, r_t . The robot moves around for a while and comes up with the experiences shown in Table 3.

Table 3: Experience achieved in 5 iterations for Question 6

t	s_t	a_t	s_{t+1}	r_t
0	A	Up	B	2
1	B	Up	B	-4
2	B	Down	B	0
3	B	Down	A	3
4	A	Down	A	-1

Now, answer the following questions based on the scenario mentioned above:

- a) Formulate the scenario as a sample-based Q-learning problem by determining Q-values for each state-action pair based on the experience of the robot. 22
 Assume that the discount factor, $\gamma = 0.5$ and the learning rate, $\alpha = 0.5$. (CO2)
(PO2)
- b) Determine the optimal policy from the scenario. 3
(CO3)
(PO2)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4733: Digital Image Processing

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets. Symbols have usual meaning taught in class.

1. a) Suppose you have a gray-scale image, f upon which you have applied morphological opening operation with a structuring, B , and have obtained an output, g . Now you applied another opening operation and obtained h . Differentiate the changes that may be observed between g and h with explanation. 7
(CO2)
(PO2)
- b) Show the validity of the duality expression: 5
(CO1)
(PO1)

$$(A \bullet B)^c = (A^c \circ \hat{B})$$
- c) Suppose your image is suffering from non-uniform illumination problem and your foreground is dark objects against a brighter background. How can you solve this illumination problem? 5
(CO1)
(PO1)
- d) Consider the following binary image shown in Figure 1. Determine the area of each dark object. Assume there are only objects of two sizes only. 8
(CO1)
(PO1)

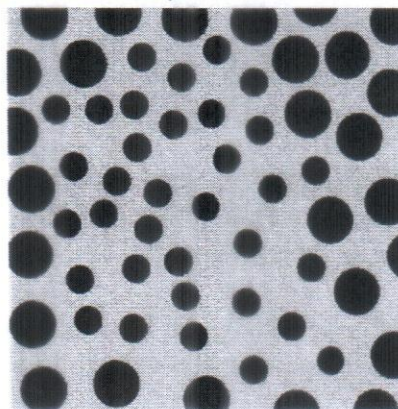


Figure 1: Figure for Question 1.d)

2. a) Mathematically show that can you compute the 2D Fourier Transform by first computing a 1D Fourier transform along the individual rows of an input image, followed by another 1D Fourier transform along the columns of the results from the output of the first transform. 8
(CO1)
(PO1)
- b) Design a filter in the Frequency Domain applying which can give you the output equivalent to applying a high-boost filter in the Spatial Domain. 7
(CO3)
(PO3)
- c) The dc term, $F(0, 0)$ of a DFT is proportional to the average value of its corresponding spatial image, f . Here, DFT is computed using the following equation: 5+5
(CO2)
(PO2)

$$F(u, v) = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x, y) \exp[-j2\pi(ux / M + vy / N)]$$

Assume that the image is of size $M \times N$. Suppose that you pad the image with zeros to $P \times Q$ size, where P and Q are greater than M and N , respectively. Let $F_P(0, 0)$ denote the dc term of the DFT of the padded image.

- i. What is the ratio of the average values of the original and padded images?
- ii. Is $F_P(0, 0)$ equal to $F(0, 0)$? Justify your answer.

- 3. a) Explain why second-order derivative responses are more sensitive than first-order derivatives when detecting zero-crossing? 5
(CO1)
(PO1)
- b) Find the edges corresponding to the minimum-cost path in the image shown in Figure 2. 10
(CO1)
(PO1)

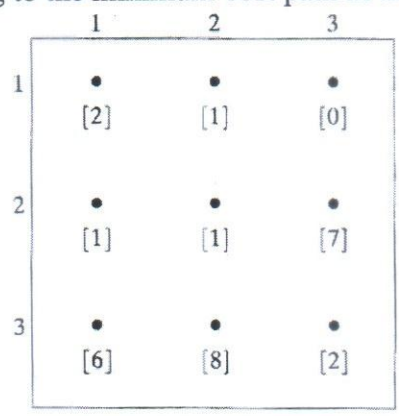


Figure 2: Figure for Question 3. b)

The numbers in brackets are gray levels and the numbers outside the image are spatial coordinates. Assume the edge starts in the first column and ends in the last column.

- c) Design a 3x3 filter for performing Laplacian of Gaussian (LoG) in a single pass. Derive first the mathematical expression for the LoG mask. 10
(CO3)
(PO3)
- 4. a) Suppose you have applied a Sobel mask which produces strong responses for horizontal edges but none for vertical edges. Why does this mask also produce weak responses for +45° and -45° oriented edges? 5
(CO1)
(PO1)
- b) Show that Hough Transform can detect partially occluded circles of fixed radius r . 10
(CO1)
(PO1)
- c) When considering the $\rho\theta$ -parameter space, show that the number of operations required to implement the accumulator cell for Hough Transform is linear in n , the number of foreground points in the image plane (i.e., the xy-plane). 10
(CO1)
(PO1)
- 5. a) Suppose you have applied Global Histogram Equalization (GHE) technique on an 8-bit gray-scale image. What will be average intensity value of the output image? Justify your answer. 10
(CO1)
(PO1)
- b) Suppose that you filter an image, $f(x,y)$ with a spatial filter mask, $w(x,y)$, using convolution, where the mask is smaller than the image in both spatial directions. Show that, if the coefficients of the mask sum to zero, then the sum of all the elements in the resulting convolution array (filtered image) will also be zero (you may ignore computational inaccuracies). Also, you may assume that the border of the image has been padded with the appropriate number of zeros. 10
(CO1)
(PO1)
- c) What is an isotropic filter? Show that a Gradient mask can be considered isotropic if only 180° rotations happen (Ignore the sign change effect). 5
(CO1)
(PO1)
- 6. a) Compare between HSI and RGB color models. 10
(CO2)
(PO2)
- b) What problems will occur if you detect edges in color images using channel-wise gradients? How can you solve this problem? 5+5
(CO1)
(PO1)
- c) Smoothing a color image in the vector-space using linear filter is equivalent to smoothing the individual color channels – justify this statement. 5
(CO2)
(PO2)

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
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Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

SWE 4739: Embedded Software Development

Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

-
- | | | |
|----|--|-----------------------|
| 1. | a) What is an Embedded Software? What are the development tools and software components that are used in developing Embedded Software? | 7
(CO1)
(PO1) |
| | b) Explain the design challenges of an Embedded System. How are these challenges different from a Desktop application? | 8
(CO2)
(PO1) |
| | c) Discuss the characteristics of an Embedded Software. What are the differences between an Embedded Software and an Embedded System? | 7+3
(CO2)
(PO1) |
| 2. | a) It is common to use a microprocessor or a microcontroller to develop an Embedded System. What factors do you consider to choose a microprocessor or a microcontroller? | 5
(CO1)
(PO1) |
| | b) Explain in detail the hypothetical design flow of an Embedded System. Briefly discuss Gajski's Y chart iterative design flow with an example. | 10
(CO2)
(PO1) |
| | c) Processors can be varied into three to develop Embedded Software in their customization of the problem. Discuss their pros and cons with an example. | 10
(CO2)
(PO1) |
| 3. | a) How do the linker and the loader work? Write five differences between the Linker and the Loader. | 5+5
(CO2)
(PO1) |
| | b) Design a combinational circuit using Read Only Memory (ROM) that takes 3-bit numbers as inputs and generates an output binary number equal to the square of the input number. | 15
(CO2)
(PO2) |
| 4. | You are given a pseudocode that calculates the Greatest Common Divisor (GCD) of two numbers shown in Figure 1. | |
| | a) Design a single-purpose processor with the following requirements: | 3×5
(CO3)
(PO3) |
| | i. Finite State Machine with Data (FSMD) | |
| | ii. Datapath | |
| | iii. FSM controller | |


```

int x, y;
while(1){
    while(!go_in);
    x = x_in;
    y = y_in;
    while(x!=y){
        if(x<y)
            y = y - x;
        else
            x = x - y;
    }
    d_out = x;
}

```

Figure 1: GCD of two numbers for Question 4.

b) Optimize the implementation shown in Figure 1, and based on the modified code snippet, update the requirements mentioned in Question (4.a).

2+8
(CO3)
(PO3)

5. Assume an Embedded System where two voltage sources (15V and 10V) and one microprocessor are attached. The microprocessor can use one of the voltage sources at a given time. For a specific task, the distributions of time and cost of energy over the number of cycles are given in Figure 2. **Specification of the task:** a basic home intruder detection system that consists of a PIR sensor, a Buzzer, and a red LED bulb. Whenever there is a movement of the given area that PIR is covered, the Buzzer will sound and the bulb will start blinking.

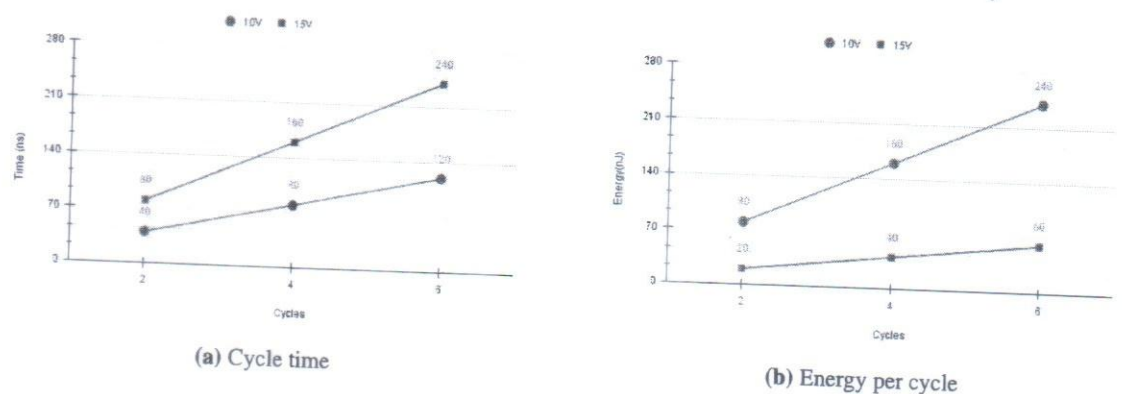


Figure 2: Distribution of time and energy over cycles.

- a) Analyze the above specification and write the *setup()* and *loop()* functions for Arduino.
- b) According to the above scenario, find the optimal combination where a task needs to execute 10^9 cycles within 25 seconds. To find the optimal combination, you can split the total time into 5 intervals.
- c) What are the things you consider for optimization? Explain with examples considering both hardware and software.

5
(CO1)
(PO1)
10
(CO2)
(PO1)
10
(CO2)
(PO1)

6. Consider the following scheduling problem consisting of three tasks (assume that all tasks arrive at time 0). Here, Rate Monotonic Scheduling (RMS) and Earliest Deadline First (EDF) are applied to measure the performance of the scheduling problem.

Table 1: Data for Question 6.

Task	Period	Deadline	Execution Time (s)
A	10	10	4
B	15	15	4
C	18	18	6

a) From an implementation perspective, what are the advantages/disadvantages of an RMS vs. an EDF scheduler?

5
(CO1)
(PO1)

b) Compare the performance of RMS and EDF on the above task sets.

20
(CO3)
(PO2)

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4739: Data Mining

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

- 1. a) Calculate the pair-wise item similarities using the Pearson Correlation as the similarity measure when nearest neighbor, $N = 3$, based on the user-item rating matrix given in Table 1.

15
(CO2)
(PO1)

Table 1: User-item Rating Matrix for Question 1

User	Item		
	I1	I2	I3
U1	2	3	1
U2	5	3	3
U3	4	2	3
Alice	-	4	3

- b) Calculate the estimated rating of item I1 for Alice given in Table 1.

10
(CO2)
(PO1)

- 2. a) Considering the support threshold, $s = 50\%$, compute all frequent itemsets using the Apriori Algorithm for the dataset given in Table 2. Show the detailed process of your answer, including candidate itemsets generation and pruning. Explain when necessary.

15
(CO2)
(PO1)

Table 2: Dataset for Question 2

TransactionID	Items
T1	{1,2,4,6}
T2	{1,2,3,4,5}
T3	{1,2,3,5}
T4	{1,2,4}

- b) Based on the answer to Question 2. (a), figure out all the strong association rules (with support s , confidence c) for the frequent itemsets generated from Table 2, matching the following metarule, where X is a variable representing customers, and item denotes variables representing items (e.g., "1," "2,"). Note that the minimum support, $s = 50\%$ and confidence, $c = 80\%$.

10
(CO2)
(PO1)

$$\forall x \in \text{transaction}, \text{buys}(X, \text{item}_1) \wedge \text{buys}(X, \text{item}_2) \Rightarrow \text{buys}(X, \text{item}_3) [s, c]$$

- 3. Elon Musk wants to design an efficient data warehouse to facilitate the analysis of Tesla's self-driving vehicles in an online analytical processing manner. Tesla registers huge amount of data related to each of its self-driving vehicles along several dimensions, such as, *Vehicle*, *Location*, *Speed*, *Fuel*, and *Time*. Each *Vehicle* is represented by information, such as, *vehicle_ID*, *vehicle_category*, *vehicle_name*, *driver_category*, etc., and each *Location* may be associated with a street in a city. For now, Elon wants to keep track of two measures: *vehicles_sold* and *vehicle_mileage*, where *vehicle_mileage* is the total number of miles a vehicle has covered.

- a) Design a data warehouse that satisfies Elon's requirements using a Star Schema.

10
(CO3)
(PO3)

- b) Hypothetically, if there were 5 levels of concept hierarchy per dimension (including all) in the data warehouse you designed in Question 3. (a), calculate the total number of cuboids that could be generated (including the base and apex cuboids).

5
(CO2)
(PO1)

- c) Starting from the base cuboid (*vehicle, location, speed, fuel, time*), point out the specific OLAP operations that should be performed in order to list the total milage covered by each vehicle type in each city in 2018 and 2020, where the fuel consumed per vehicle was more than 200L. 10
(CO2)
(PO1)
4. a) Assume that you are clustering 1 million points. Each point is represented by 3 integer attributes, and there will be 4 clusters. Determine the total main memory required for the following conditions: 7
(CO2)
(PO1)
- i. If you are using k-means algorithm for clustering
- ii. If you are using BFR algorithm for clustering
- b) Suppose you have the following three clusters in some dataset: 10
(CO2)
(PO1)
- Cluster1: (5, 7), (6, 9), (8, 12)
- Cluster 2: (12, 6), (14, 5), (15, 5)
- Cluster 3: (2,3), (0, 2), (3,1)
- Determine the summary of the clusters according to BFR algorithm.
- c) For a Mahalanobis acceptance criterion of $3\sqrt{d}$ (where d = number of dimensions), determine whether a new point (5, 1) belongs to any of the clusters mentioned in Question 4. (a) in the discard set, or whether it belongs to the retained set. 8
(CO2)
(PO1)
5. a) Write short notes on the following: 2+3+4
+5
(CO1)
(PO1)
- i. Parameter and Hyperparameter in a machine learning model
- ii. Soft margin and Hard margin in SVM
- iii. C and Gamma hyperparameter tuning in SVM
- iv. The purpose of kernel functions in SVM with example
- b) Explain how you would evaluate the performance of a classification model with example. 6
(CO2)
(PO1)
6. a) Model a C4.5 Decision Tree algorithm using the training data (RIDs 1 to 14) in the dataset shown in Table 3. Create a rough sketch of the obtained decision tree. 20
(CO3)
(PO3)

Table 3: Dataset for Question 6
(Training Set: RIDs 1 to 14, Testing Set: RIDs 15 to 18)

RID	Student_Status	Allowance	Owens_Console	Social_Life	Class: upgrades_pc_gpu
1	Junior	High	No	Fair	No
2	Junior	High	No	Very active	No
3	Sophomore	High	No	Fair	Yes
4	Senior	Medium	No	Fair	Yes
5	Senior	Low	Yes	Fair	Yes
6	Senior	Low	Yes	Very active	No
7	Sophomore	Low	Yes	Very active	Yes
8	Junior	Medium	No	Fair	No
9	Junior	Low	Yes	Fair	Yes
10	Senior	Medium	Yes	Fair	Yes
11	Junior	Medium	Yes	Very active	Yes
12	Sophomore	Medium	No	Very active	Yes
13	Sophomore	High	Yes	Fair	Yes
14	Senior	Medium	No	Very active	No
15	Junior	High	No	Fair	No
16	Sophomore	High	No	Fair	Yes
17	Senior	Low	Yes	Fair	Yes
18	Sophomore	Low	Yes	Very active	No

- b) Calculate the F1 score of your trained algorithm in question 6. (a) Using the testing set shown in Table 3 (RIDs 15 to 18). 5
(CO2)
(PO1)
- c) Explain how you would solve the problem of overfitting in a decision tree model. 5
(CO2)
(PO1)

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

Math 4741: Mathematical Analysis

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Bonus-malus system is based on penalizing insurance holders who are responsible for one or more claims by a premium surcharge, and awarding insurance holders with a premium discount if they have few claims. 15
(CO1)
(PO1)

If we suppose that the number of yearly claims made by a particular policyholder is a Poisson random variable with a mean of 0.4, then what is the average annual premium paid by an insured?

State	Annual Premium (\$)	Next State if				
		0 Claim	1 Claim	2 Claims	3 Claims	>= 4 Claims
1	100	1	2	2	2	3
2	270	1	2	2	3	3
3	450	2	2	3	3	3

- b) i. If 3% of electronic units manufactured by a company are defective, find the probability that in a sample of 200 units, less than 2 bulbs are defective. 3
(CO1)
(PO1)

- ii. An insurance company insures a large number of homes. The insured value, \$X, of a randomly selected home is assumed to follow the given distribution with the probability density function: 3
(CO1)
(PO1)

$$f(x) = \left\{ \begin{array}{ll} \frac{3}{x^4} & x > 1, \\ 0 & \text{otherwise} \end{array} \right\}$$

Given that a randomly selected home is insured for at least \$1.5, calculate the probability that it is insured for less than \$2.

- iii. Let X be a continuous random variable with PDF given by: 4
(CO1)
(PO1)
- $$f(x) = \frac{1}{2} e^{-|x|}, \text{ for all } x \in \mathbb{R}$$

If $Y = X^2$, find the CDF of Y and represent it as a graph.

- 2. a) i. Marvin is arguing with his mom about buying a \$150 light. His mom wants him to be safe, but Marvin thinks that lights are too expensive. Based on traffic data, Marvin makes the table below which shows the time, probability, and cost of three different types of accidents if Marvin does not have the light. If Marvin purchases the light, it will not matter in the morning or at dusk, but it will prevent a night accident from occurring. Assume that Marvin can get in at most one accident and that Marvin's table is accurate. Compare the expected total cost of accidents and lights in the cases that Marvin buys the light and in the case that he does not buy the light. If Marvin wants the best payoff in the long run, what should he do? 10
(CO2)
(PO2)

Time of accident	Cost (\$)	Probability (%)
Morning	2000	10
Dusk	4000	15
Night	2000	20

- ii. After COVID peaked, millions of Americans quit their jobs to take advantage of a tight labor market, a phenomenon being called the great resignation. Suppose Dave is unsure whether he should take part in the great resignation or not. Dave is currently working for \$40,000 a year. He thinks that if he quits his job and works for himself that there is a 50% chance he could earn \$20,000 in their first year, a 30% chance he could earn \$60,000, and a 10% chance he would earn \$0. There is a 10% chance he falls sick, in which case he will need to spend \$10,000 in medical fees in one year. If he needs \$20,000 annually for his expenses, should he quit his job? 5
(CO3)
(PO3)

- b) i. Suppose variable X has a binomial distribution with parameters $n=6$ and $p=0.5$. Show that $X=3$ is the most likely outcome over a large number of trials. 2
(CO1)
(PO1)

- ii. What would the most likely outcome over a large number of trials be, if X has a geometric distribution? 2
(CO1)
(PO1)

- c) i. Suppose you order a pizza from your favorite pizzeria at 7:00 pm, knowing that the time it takes for your pizza to be ready is uniformly distributed between 7:00 pm and 7:30 pm. What is the probability that you will have to wait longer than 10 minutes for your pizza? 3
(CO1)
(PO1)

- ii. If at 7:15pm, the pizza has not yet arrived, what is the probability that you will have to wait at least an additional 10 minutes? 3
(CO1)
(PO1)

- 3. a) Explain the following with examples: 2
 - i. Memoryless property (CO1)
(PO1)
 - ii. Transient states 2
(CO1)
(PO1)

- b) Consider a rover that operates on a slope and uses solar panels to recharge. It can be in one of three states: high, medium and low on the slope. If it spins its wheels, it climbs the slope in each time step (from low to medium or from medium to high) or 5
(CO2)
(PO2)

stays high. If it does not spin its wheels, it slides down the slope in each time step (from high to medium or from medium to low) or stays low. Spinning its wheels uses one unit of energy per time step. Being high or medium on the slope gains three units of energy per time step via the solar panels, while being low on the slope does not gain any energy per time step. The robot wants to gain as much energy as possible. Represent this problem as a Markov Decision Process graphically.

c) Suppose that a production process changes states in accordance with the Markov chain given below $S=\{1, 2, 3\}$ and that states 1 and 3 are considered acceptable and the remaining state is unacceptable.

	1	2	3
1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{4}$
2	$\frac{1}{3}$	0	$\frac{2}{3}$
3	$\frac{1}{2}$	$\frac{1}{2}$	0

- i. What is the rate of breakdowns (rate of change from acceptable to unacceptable states) in this process? 10
(CO1)
(PO1)
- ii. What is the average length of time that the process is in acceptable states? 3
(CO1)
(PO1)
- iii. What is the average length of time that the process is in unacceptable states? 3
(CO1)
(PO1)

4. a) Poker is a classic game of chance, in which each player is dealt a hand of five cards. The player with the best five-card hand wins. For three of a kind, the hand will look like $\{x,x,x,y,z\}$ for some distinct values. What is the probability of getting a hand with three of a kind? 6
(CO1)
(PO1)

- b) i. Explain the Gambler's Ruin problem with a state transition diagram. 5
(CO1)
(PO1)
- ii. Let P_i denote the probability that, starting with i , the gambler's fortune will eventually reach N . Derive an equation for P_i . 10
(CO2)
(PO2)
- iii. Suppose Dan and Mary decide to flip pennies; the loser gives their penny to the winner. Mary has a probability 0.55 of winning on each flip. If Mary starts with 7 pennies and Dan with 19, what is the probability that Dan will take all of Mary's pennines? 4
(CO1)
(PO1)

5. a) i. Suppose that whether or not it is sunny today depends on previous weather conditions through the last two days. If it has been sunny for the past two days, then it will be sunny tomorrow with probability 0.7; if it is sunny today but not yesterday, then it will be sunny tomorrow with probability 0.5; if it was sunny yesterday but not today, then it will be sunny tomorrow with probability 0.4; if it was not sunny in the past two days, then it will be sunny tomorrow with probability 0.2. Denote the weather conditions as a Markov chain and create a state transition matrix. 6
(CO2)
(PO2)

- ii. Given that it was sunny on Sunday and Monday, what is the probability that it will not be sunny on Wednesday? 9
(CO2)
(PO2)

- b) A certain bus provides service in two zones of a city. Fares picked up in zone A will have destinations in zone A with probability 0.7 or in zone B with probability 0.3. Fares picked up in zone B will have destinations in zone A with probability 0.8 or in zone B with probability 0.2. The expected profit for a trip entirely in zone A is 5; for a trip entirely in zone B is 9; and for a trip that involves both zones is 14. Find the bus's average profit per trip. 10
(CO4)
(PO3)

- 6. a) An urn always contains 2 balls which may be colored red or blue. At each stage a ball is randomly chosen and then replaced by a new ball. There is a probability of 0.8 that it is of the same color, and a probability of 0.2 that it is of the opposite color as the ball it replaces. If initially both balls are red, find the probability that the fifth ball selected is red. 6
(CO2)
(PO2)

- b) The Hardy-Weinberg Law is a principle stating that the variation in a population will remain constant from one generation to the next in the absence of disturbing factors. Design a statistical method by which this law can be proven. 9
(CO4)
(PO3)

- c) The number of traffic accidents on successive days are independent Poisson random variables with mean 2. 5
(CO1)
(PO1)
 - i. Find the probability that 3 of the next 5 days have two accidents.
 - ii. Find the probability that there are a total of 6 accidents over the next 2 days. 5
(CO1)
(PO1)



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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
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Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4743: Cryptography and Network Security

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Which security mechanism(s) is/are provided in each of the following cases? 5×2
(CO1)
(PO1, PO2)
- i. A school demands student identification and a password to let students log into the school server.
 - ii. A school server disconnects a student if she is logged into the system for more than two hours.
 - iii. A professor refuses to send students their grades by e-mail unless they provide student identification they were preassigned by the professor.
 - iv. A bank requires the customer's signature for a withdrawal.
 - v. A student uses Rabin-Karp hash algorithm to perform the string-matching task.
- b) Satoru obtained a cipher text "*EKF HUSF 66 C8L7U5*" and wants to decrypt it. He also found: 10
(CO2)
(PO1, PO2)
- i. the key, $k = 23$
 - ii. the plaintext was made of letters (a to z) and digits (0 to 9)
 - iii. the encryption algorithm was Multiplicative cipher
- Help Satoru by uncovering (decrypting) the secret message.
- c) The encryption key in a transposition cipher is (3, 2, 6, 1, 5, 4). Compute the decryption key. 5
(CO2)
(PO1, PO2)
2. a) Encrypt the message "*We live in an insecure world*" using Hill cipher with the following key. 10
(CO2)
(PO1, PO2)
- $$K = \begin{bmatrix} 03 & 02 \\ 05 & 07 \end{bmatrix}$$
- Use 'z' as the bogus character.
- b) Use Playfair Cipher to encipher the message "*mecha kawai des ne*". The secret key can be made by filling the first and part of the second row with the word "**PLAYFAIR**" and filling the rest of the matrix with the rest of the alphabet sequentially. (Use x as the bogus character) 8
(CO2)
(PO1, PO2)
- c) Modern Block Ciphers have two properties, Diffusion and Confusion. Show how these traits are upheld by the Product Ciphers. 7
(CO1)
(PO1, PO2)

3. a) "Symmetric-key exchange is better than Asymmetric-key exchange." – Analyse this statement with valid arguments and examples. 5
(CO2)
(PO1, PO2)
- b) Amano wants to send Erika a message "*Section A is better*" using on RSA cryptosystems. In this system, the prime-product is n and the public key is e . (Ignore the spaces while encrypting) 7+7+1
(CO2)
(PO1, PO2)
- i. Given $n = 12091$ and $e = 3$. Encrypt the message and find the private key, d for Erika so that she can decrypt the message.
 - ii. Given $n = 100$ and $e = 3$. Encrypt the message and find the private key, d for Erika so that she can decrypt the message.
 - iii. Determine which cryptosystem works in a real-life scenario.
- c) Max argues that the hashing algorithm MD-5 is better than SHA-1. Lewis disagrees and states the opposite. However, both agree that these algorithms require padding of input bits even if they are a multiple of 512 bits. 5
(CO1)
(PO1, PO2)
Identify why padding is required in this circumstance and elucidate the security goal associated with these hashing algorithms.
4. a) The Needham-Schroder protocol is susceptible to the *Replay Attack* as depicted in Figure 1. 10
(CO3)
(PO1, PO2)

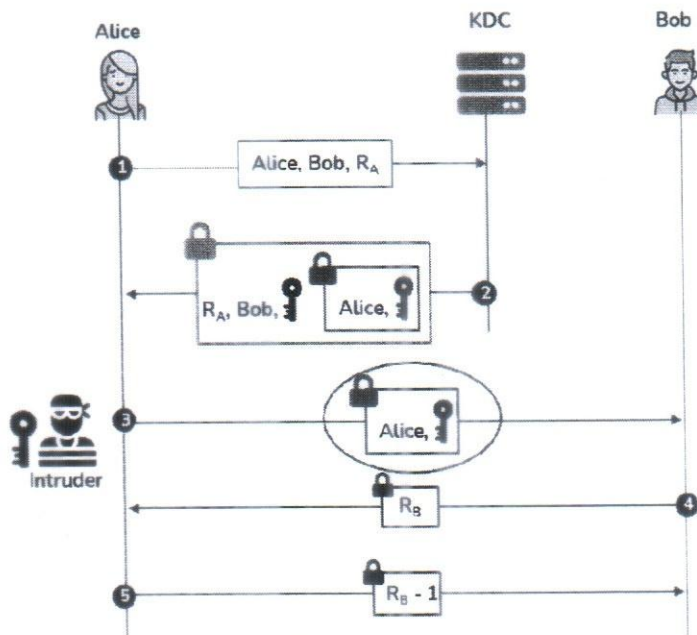


Figure 1: Replay Attack

Analyse the cause for this vulnerability. Identify the mechanism to circumvent this vulnerability with appropriate diagrams.

- b) Illustrate a variant of Kerberos with diagrams which adheres to the following guidelines and answer the following questions. 7.5×2
(CO3)
(PO1, PO2)
- i) The workstation generates a Ticket Granting Ticket (TGT). The TGT will be encrypted with the user's master key rather than the KDC's master key.
 - ii) Compare this design with standard Kerberos in terms of efficiency and security? What happens in each scheme if the user changes her password during a login session?

5. a) The IPSec IKE Phase – I exchanges keys via the Diffie-Hellman technique. However, this technique is susceptible to Man-in-the-Middle (MITM) attack as illustrated in Figure 2.

3+7
(CO3)
(PO1, PO2)

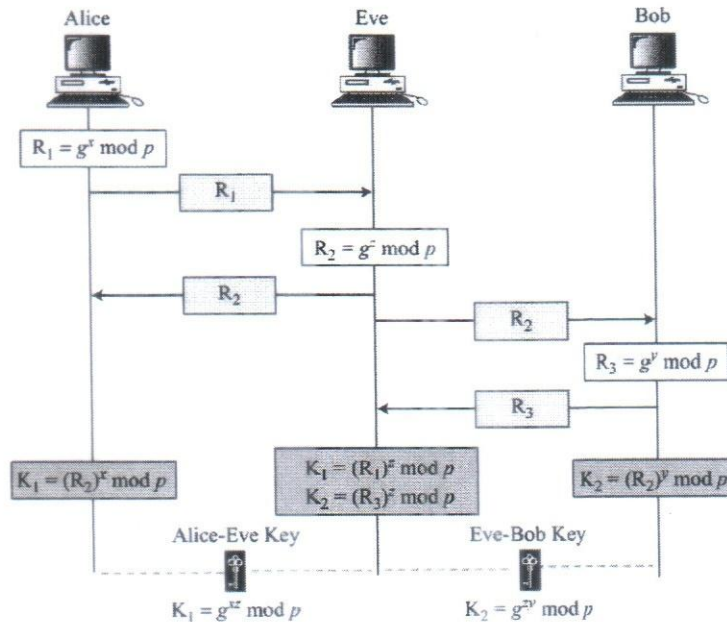


Figure 2: MITM Attack in IKE Phase – I

Now, answer the following questions.

- i. Analyse how the MITM attack can be thwarted.
 - ii. Eve launches another attack by sending several half-keys to Bob (Server), masquerading herself as if these keys are from multiple sources. Determine with appropriate diagrams how this attack can be prevented.
- b) IPSec provides a service against Replay Attacks as demonstrated in Figure 3.

10
(CO3)
(PO1, PO2)

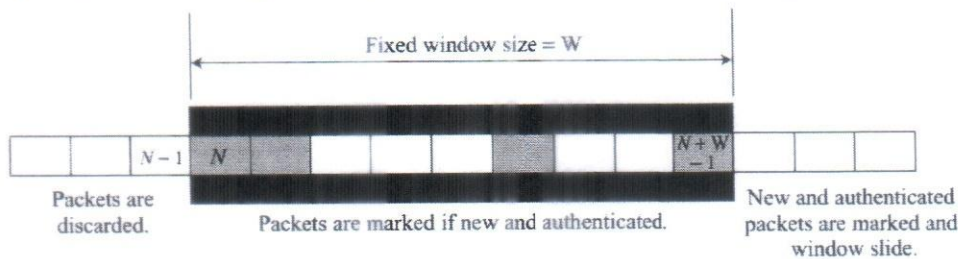


Figure 3: Replay Attack Protection

A host receives authenticated packets with the sequence numbers 181, 192, 224, 264, and 333. The replay window has a default size of 64, currently starting from sequence number 200.

What will the host do with the packets? What is the window span after each event?

- c) Ayanokoji-kun wants to send a secret message to Karuizawa using the Cipher Feedback (CFB) operation. Determine the ciphertext for the first block if the original message is (CE2F 7DF6 B1A5 42C3)₁₆ and the encrypted Initialization Vector (IV) is (AD25 EF96 CFB3 4D7F)₁₆. Consider each ciphertext block size is 8 bits.

5
(CO2)
(PO1, PO2)

6. a) When a session is resumed with a new connection, SSL does not require the full handshaking process. Examine and illustrate the messages that need to be exchanged in a partial handshaking. Use diagrams, if necessary. 7
(CO3)
(PO1, PO2)
- b) Compare and contrast the protocols defined in SSL and TLS. Deduce the goals of each protocol in SSL and TLS. 8
(CO3)
(PO1, PO2)
- c) Security at the Transport layer employs multiple key-exchange algorithms. Answer the following questions. 5×2
(CO3)
(PO1, PO2)
- i. Assess the key exchange algorithms in SSL/TLS and judge which algorithms are more or less immune to malicious attacks.
 - ii. "If an adversary reverse-engineers to find the encryption key, then the entire client-server connection is compromised" – Justify this statement.

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

HUM 4747: Legal Issues and Cyber Law

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Imagine while working on your final thesis in IUT, you come up with an innovative product that has potential for business both in Bangladesh and abroad. To protect your product from being copied by big corporates, you need to have a patent of your product. 8
(CO3)
(PO6)
 - i. Briefly outline the procedure that you need to follow to have a patent in Bangladesh. Also explain the administrative remedies you will get after getting the patent.
 - ii. Is it possible to have the patent for your product that works for the other region of the world? State the reasons behind your answer. 5
(CO1)
(PO8)
- b) Briefly explain the different steps in applying and getting a patent under PCT, with the help of the overview and timeline diagram. 12
(CO1)
(PO6)
2. a) Suppose you recently joined a company and you heard your colleagues talking about how the company monitors and tracks employees' activities in the workplace. 7
(CO2)
(PO6)
 - i. What do you understand about workplace privacy? Explain the privacy issues that can arise when you are in the workplace.
 - ii. Name 3 tools employers normally use to monitor and track employees. What are the most common reasons employers want to monitor employees' workplace activity? 6
(CO1)
(PO2)
- b) To safeguard business resources and potential business loss, we can make use of Patent, Trademark, Copyright, NDA, etc. Briefly compare Patent, Trademark, Copyright and NDA with the context in which they are deployed. 12
(CO1)
(PO2)
3. a) Digital forensic is an important aspect when presenting a cyber-crime to the court of law. Suppose a cybersecurity attack took place in Bangladesh Bank. Thirty-five fraudulent instructions were issued by security hackers via the SWIFT network to illegally transfer close to US\$2 billion from the Federal Reserve Bank of New York account belonging to Bangladesh Bank. Assume that you are a famous Information Security specialist and Bangladesh Bank contacted you to conduct an investigation to support the law team regarding the above mentioned incident. Briefly explain the steps and activities you will take to support the law team in the above context. 18
(CO3)
(PO2)
- b) What is 'steganography' and how is it related to digital forensic? What is the difference between 'steganography' and 'cryptography'? 7
(CO2)
(PO4)
4. a) What do you understand by cybercrime and cybersecurity? Briefly explain the different cybersecurity control types with examples. 10
(CO1)
(PO1)

- b) What are the main human factors in cybersecurity? *“Cybersecurity is not a purely technical problem for the technical team. People are more likely to create cybersecurity failures than technology is.”* Do you agree with this statement? Explain the reasons behind your answer from the perspectives of human factors in cybersecurity. 15
(CO2)
(PO6)
- 5. a) In the modern world, use of electronic documents is getting increasingly popular. Sometimes, to secure the documents, digital signatures are used. 8
(CO1)
(PO1)
 - i. What do you understand by “E-contract” and “digital signature”? What are the differences between them?
 - ii. Explain the role of CA in the digital signature deployment process. 8
(CO1)
(PO1)
- b) Several guidelines have been provided over time for passing any act pertaining to ICT and Cyberspace in Bangladesh with a specific context. According to the Cyber Security Guideline from 11 March, 2014, briefly explain the national priorities on any national cybersecurity strategy should have? What actions are necessary to maintain the 2nd priority? 9
(CO4)
(PO2)
- 6. a) As part of regulatory or compliance controls, Cyber Law comes into existence and we expect cyber law helps in controlling cybercrime. Digital Security Act, 2018 is the most prominent law in Bangladesh to protect the cyberspace. 8
(CO1)
(PO6)
 - i. Briefly explain the role of Digital Security Agency and National Digital Security Council to protect our cyberspace as per the law.
 - ii. What is the difference between digital/electronic forgery and fraud? What are the existing laws as per the DSA 2018 to protect from the two mentioned crimes? 8
(CO2)
(PO2)
- b) As per ICT Act 2006, how can electronic records and electronic signatures be used in government and its agencies? Also state the rules regarding securing electronic records and digital signature as per this act. 9
(CO1)
(PO6)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4749: Introduction to Cloud Computing

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) You are newly employed as a cloud architect at a startup company in Bangladesh. The company wants to setup an e-commerce website, for selling their products. After speaking to the manager, you have gathered some information regarding the website. The manager tells you that sometimes during the year, their product has a very high demand and other times, not so much. Moreover, their largest customer base is in North America and South-East Asia. The manager is working very hard to increase the daily website traffic. They also plan to improve the website considerably over time by adding more features like "suggesting similar products" after a user orders a specific product. But one of the managers' concerns is security of the user and company data in the cloud. Based on this information, design a cloud architecture that can be deployed in AWS and will satisfy all the needs of the company. For every resource that is included in your architecture, mention its' purpose or the problems or concerns it actually resolves. 20
(CO4)
(PO2)
- b) What is Hybrid Cloud Deployment? Draw its network architecture. 5
(CO1)
(PO1)
2. a) Elaborate on the following type of VM migration. Discuss their *downtime* and *migration duration*. 9
(CO1)
(PO1)
 - i. Stop-and-copy (S-C)
 - ii. Demand-Migration (D-M)
 - iii. Iterative Pre-copy (I-P)
- b) With the help of a diagram, explain the *Hadoop* architecture. 6
(CO2)
(PO1)
- c) "*Mobile devices could benefit from cloud computing*", explain the reasons why you think that this statement is true, or provide arguments supporting the contrary. Discuss *three* cloud applications for mobile devices; explain which one of the three cloud computing delivery models SaaS, PaaS, or IaaS would be used by each one of the applications and why? 10
(CO3)
(PO2)
3. a) What is IAM in AWS cloud? 4
(CO1)
(PO1)
- b) With the help of a diagram, explain the 4 layered network defenses for a Virtual Private Cloud (VPC). For each layer of security, mention a use case where the security will be important. 15
(CO1)
(PO1)
- c) What are the best practices to maintain account security on a cloud platform like AWS? 6
(CO2)
(PO1)

4. a) Use Map-Reduce to solve the following problem. 12
(CO4)
(PO2)
- The input contains two lists. One list gives voter information for every registered voter: (*voter-id, name, age, zip*). The other list gives disease information: (*zip, age, disease*). If a particular age/zip pair appears in one input list but not the other, then that age/zip pair can appear in the output with an empty list of names or diseases, or you can omit it from the output entirely, depending on which is easier. For each unique pair of age and zip values, the output should give a list of names and a list of diseases for people in that zip code with that age.
- (Hint: the keys in a map/reduce step do not need to be single atomic values.)
- b) Consider an input of a large collection of weather observation data. Each line of the input data gives information about a single observation and contains the following: 8
(CO4)
(PO1)
Station_ID, City, Division, Elevation, Year, Month, Day, Time, Temperature and Precipitation.
Print the maximum temperature for each city for every year in the database. Note that the city names may not be unique but there may not be two cities in the same division.
- c) Discuss the issues of virtualization on - 5
(CO1)
(PO1)
- Hardware sharing
 - Performance
 - Migration of virtual machines.
5. a) What is a columnar database? With the help of a diagram, explain the step-by-step process of writing to a file in the HBase architecture. 8
(CO1)
(PO1)
- b) What is HDFS? Explain job management in HDFS with Architecture. 8
(CO1)
(PO1)
- c) Differentiate between the following: 3x3
(CO1)
(PO1)
- i. Private cloud and Public cloud
 - ii. Scalability and Elasticity in cloud computing
 - iii. Grid computing, Utility computing and Cloud computing.
6. a) Discuss the different service model in cloud computing. For every service model, give an example and state the level of abstraction at that service model. 9
(CO1)
(PO1)
- b) Explain about Amazon Simple Storage service. 4
(CO1)
(PO1)
- c) BdTel is a new telecommunication company that provides mobile voice and multimedia services across Bangladesh. The company generates billions of Call Detail Records (CDR). Traditional database systems were unable to scale up to the vast volumes of data and provide a cost-efficient solution. Storing and Real-time analysis of billions of records we identified as problem.
- i. Explain how each one the five Vs of Big Data falls into the mentioned problem. 6
(CO3)
(PO1)
 - ii. How would you solve the mentioned Big Data problem? 6
(CO2)
(PO2)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4559: Introduction to Cloud Computing

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1. a) You are newly employed as a cloud architect at a startup company in Bangladesh. The company wants to setup an e-commerce website, for selling their products. After speaking to the manager, you have gathered some information regarding the website. The manager tells you that sometimes during the year, their product has a very high demand and other times, not so much. Moreover, their largest customer base is in North America and South-East Asia. The manager is working very hard to increase the daily website traffic. They also plan to improve the website considerably over time by adding more features like “suggesting similar products” after a user orders a specific product. But one of the managers’ concerns is security of the user and company data in the cloud. Based on this information, design a cloud architecture that can be deployed in AWS and will satisfy all the needs of the company. For every resource that is included in your architecture, mention its’ purpose or the problems or concerns it actually resolves. 20
(CO4)
(PO2)
- b) What is Hybrid Cloud Deployment? Draw its network architecture. 5
(CO1)
(PO1)
2. a) Elaborate on the following type of VM migration. Discuss their *downtime* and *migration duration*. 9
(CO1)
(PO1)
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- b) With the help of a diagram, explain the *Hadoop* architecture. 6
(CO2)
(PO1)
- c) “*Mobile devices could benefit from cloud computing*”, explain the reasons why you think that this statement is true, or provide arguments supporting the contrary. Discuss *three* cloud applications for mobile devices; explain which one of the three cloud computing delivery models SaaS, PaaS, or IaaS would be used by each one of the applications and why? 10
(CO3)
(PO2)
3. a) What is IAM in AWS cloud? 4
(CO1)
(PO1)
- b) With the help of a diagram, explain the 4 layered network defenses for a Virtual Private Cloud (VPC). For each layer of security, mention a use case where the security will be important. 15
(CO1)
(PO1)
- c) What are the best practices to maintain account security on a cloud platform like AWS? 6
(CO2)
(PO1)

4. a) Use Map-Reduce to solve the following problem. 12
(CO4)
(PO2)
- The input contains two lists. One list gives voter information for every registered voter: (*voter-id, name, age, zip*). The other list gives disease information: (*zip, age, disease*). If a particular age/zip pair appears in one input list but not the other, then that age/zip pair can appear in the output with an empty list of names or diseases, or you can omit it from the output entirely, depending on which is easier. For each unique pair of age and zip values, the output should give a list of names and a list of diseases for people in that zip code with that age.
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- b) Consider an input of a large collection of weather observation data. Each line of the input data gives information about a single observation and contains the following: 8
(CO4)
(PO1)
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Print the maximum temperature for each city for every year in the database. Note that the city names may not be unique but there may not be two cities in the same division.
- c) Discuss the issues of virtualization on - 5
(CO1)
(PO1)
- Hardware sharing
 - Performance
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5. a) What is a columnar database? With the help of a diagram, explain the step-by-step process of writing to a file in the HBase architecture. 8
(CO1)
(PO1)
- b) What is HDFS? Explain job management in HDFS with Architecture. 8
(CO1)
(PO1)
- c) Differentiate between the following: 3x3
(CO1)
(PO1)
- i. Private cloud and Public cloud
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 - iii. Grid computing, Utility computing and Cloud computing.
6. a) Discuss the different service model in cloud computing. For every service model, give an example and state the level of abstraction at that service model. 9
(CO1)
(PO1)
- b) Explain about Amazon Simple Storage service. 4
(CO1)
(PO1)
- c) BdTel is a new telecommunication company that provides mobile voice and multimedia services across Bangladesh. The company generates billions of Call Detail Records (CDR). Traditional database systems were unable to scale up to the vast volumes of data and provide a cost-efficient solution. Storing and Real-time analysis of billions of records we identified as problem. 6
(CO3)
(PO1)
- i. Explain how each one the five Vs of Big Data falls into the mentioned problem.
 - ii. How would you solve the mentioned Big Data problem? 6
(CO2)
(PO2)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
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Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 Hours

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

CSE 4753: Bioinformatics

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets. Symbols have usual meaning taught in class.

- 1. a) Write down the bisecting k-means algorithm for clustering. 7
(CO3)
(PO1)
- b) Explain the advantages of bisecting k-means algorithm over traditional k-means algorithm. 8
(CO3)
(PO1)
- c) Similarity matrix for five data points are shown in Table 1. 10
(CO2)
(PO2)

Table 1: Similarity matrix for Question 1.c)

	A	B	C	D	E
A	1.00	0.75	0.65	0.90	0.85
B		1.00	0.35	0.45	0.55
C			1.00	0.70	0.65
D				1.00	0.75
E					1.00

Cluster these dataset by applying agglomerative hierarchical clustering using MIN (single linkage) approach.

- 2. a) Read counts from three RNA-Seq experiments are shown in Table 2. 8
(CO3)
(PO2)

Table 1: RNA-Seq data for question 2.a)

Gene	Exp1 (M)	Exp1 (M)	Exp1 (M)
A	12	14	28
B	22	24	62
C	5	8	16
D	0	0	1

Here read counts are presented in millions (M) and length of genes A, B, C and D are 2 kb, 4 kb, 1 kb and 10 kb respectively. Now, apply TPM method to normalize the read counts.

- b) Describe the steps to prepare RNA-Seq library for high throughput gene sequencing. 10
(CO2)
(PO1)
- c) Show how various types of phylogenetic tree can represent information about kinship between nodes. 7
(CO4)
(PO2)
- 3. a) Write short note on *poly-A tail*. 4
(CO1)
(PO1)

- b) Distance matrix for 4 hypothetical sequences: S1, S2, S3, and S4 is presented in Table 3. 10
(CO3)
(PO3)

Table 3: Distance matrix for Question 3.b)

	S1	S2	S3	S4
S1	-	10	8	11
S2		-	12	7
S3			-	9
S4				-

Build a phylogenetic tree for the sequences using UPGMA (Unweighted Pair Group Method with Arithmetic Mean) method.

- c) Explain gene expression regulation mechanism in terms of regulatory sites and transcription factors. 11
(CO4)
(PO1)

- 4. a) Discuss the DNA structures developed by folding. 5
(CO2)
(PO1)

- b) List the constraints that need to be fulfilled when nucleotides of an RNA participate to form RNA secondary structure 5
(CO4)
(PO1)

- c) Predict the secondary structure for the following RNA using Nussinov Folding algorithm: 15
(CO4)
(PO1)
GUACCCUGUGGUAU

- 5. a) What information we can achieve by doing global alignment and local alignment of biological sequences? 2x4
(CO4)
(PO1)

- b) Two sequences are given as follows: 5
(CO3)
(PO1)

Sequence1: TATGCTAAC
Sequence2: GCATGCTAC

The substitution matrix corresponding to these two sequences is shown in Table 4:

Table 4: Substitution Matrix for Question 5.b)

	A	T	G	C	-
A	1	-2	-2	-2	-1
T	-2	1	-2	-2	-1
G	-2	-2	1	-2	-1
C	-2	-2	-2	1	-1
-	-1	-1	-1	-1	

Determine the initialization matrices for both Needleman-Wunsch and Smith-Waterman methods for alignment.

- c) Briefly describe Center Star Method for multiple sequence alignment with an example. 12
(CO4)
(PO3)

- 6. a) State how propensity values can be calculated for Chou-Fasman Method. 3
(CO4)
(PO1)

- b) Write down the Chou-Fasman Methods to predict protein secondary structures for Alpha helix, Beta Starnd and Beta Turn. 12
(CO4)
(PO1)

Appendix

Table 3: Free energy propagation for adjacent basepairs.

Propagation sequence	ΔH° , kcal/mol	ΔS° , eu	ΔG° , kcal/mol
AA	-6.6	-18.4	-0.9
UU			
AU	-5.7	-15.5	-0.9
UA			
UA	-8.1	-22.6	-1.1
AU			
CA	-10.5	-27.8	-1.8
GU			
CU	-7.6	-19.2	-1.7
GA			
GA	-13.3	-35.5	-2.3
CU			
GU	-10.2	-26.2	-2.1
CA			
GC	-8.0	-19.4	-2.0
CG			
CG	-14.2	-34.9	-3.4
GC			
CG	-12.2	-29.7	-2.9
GC			
Initiation	(0)	-10.8	3.4
Symmetry correction (self-complementary)	0	-1.4	0.4
Symmetry correction (non-self-complementary)	0	0	0

Table 4: Free energy increment for unpaired terminal nucleotides.

	X				X			
	A	C	G	U	A	C	G	U
	3' dangling ends				5' dangling ends			
AX					XA			
U	-0.8	-0.5	-0.8	-0.6	U	-0.3	-0.3	-0.4
CX					G			
G	-1.7	-0.8	-1.7	-1.2	XC	-0.5	-0.2	-0.2
GX					G			
C	-1.1	-0.4	-1.3	-0.6	XG	-0.2	-0.3	-0.0
UX					C			
A	-0.7	-0.1	-0.7	-0.1	XU	-0.3	-0.2	-0.2
					A			

Free-energy parameters, in kcal/mol, for RNA at 37°C in 1 M NaCl. From refs. 18, 20, 21, and 26, and N.S. and D.H.T unpublished data.

Table 5: Free energy increment for loops.

Loop size	Internal loop*†	Bulge loop*‡	Hairpin loop*§
1	—	+3.3	—
2	+0.8	+5.2	—
3	+1.3	+6.0	+7.4
4	+1.7	+6.7	+5.9
5	+2.1	+7.4	+4.4
6	+2.5	+8.2	+4.3
7	+2.6	+9.1	+4.1
8	+2.8	+10.0	+4.1
9	+3.1	+10.5	+4.2
10	+3.6	+11.0	+4.3
12	+4.4	+11.8	+4.9
14	+5.1	+12.5	+5.6
16	+5.6	+13.0	+6.1
18	+6.2	+13.6	+6.7
20	+6.6	+14.0	+7.1
25	+7.6	+15.0	+8.1
30	+8.4	+15.8	+8.9

Free-energy parameters, in kcal/mol, for RNA at 37°C in 1 M NaCl.

Li

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4773: Internetworking Protocols

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions.

1. a) Compare between Reactive Routing and Proactive Routing in brief. 5
- b) Consider a wireless LAN (WLAN) consisting of three stations (*A*, *B*, and *C*). CSMA/CA, a random-access MAC protocol is used here as a collision resolution mechanism. Assume that all the stations operate in the same frequency band, and they can all hear each other's transmission. Consider the RTS/CTS transmission as an enabled mechanism in this scenario. 20

Draw a Timeline Diagram representing the sequence of actions for a successful transmission of two Data Frames after one retransmission from Station A to Station B.

The diagram should depict the detailed backoff procedure performed by all the stations in the WLAN. Consider the minimum Contention Window, CW_{min} value is four. Note that the x-axis of the diagram should show time and y-axis should show one horizontal line for each of the contending stations in WLAN.

2. a) Why do we have a separate mechanism for Multicasting, when it can be emulated with multiple unicasting? Justify your answer with an appropriate example. 10
- b) During transmission, digital signals may suffer from noise that can introduce errors in the binary bits travelling from sender to receiver. That means a 0 bit may change to 1 or a 1 bit may change to 0. 15

Let, Station A has a data frame of 24 bits destined for Station B. Table 1 depicts the original data frame content of station A. Now, apply the **Two-dimensional Parity Check** method over the data frame and show how the receiver *Station B* can identify any error introduced during transmission.

Table 1: Original data frame content of *Station A* for Question (2.b)

Data Frame Content		
10011001	10010101	11000110

3. a) "Carrier Sense Multiple Access with Enhanced Collision Avoidance (CSMA/ECA) can create a collision-free schedule in a fully decentralized manner using a Deterministic Backoff." 17
- Clarify the statement with the aid of a Timeline Diagram. Note that the x-axis of the diagram should show time and y-axis should show one horizontal line for each of the contending stations in network.
- b) "Throughput efficiency of CSMA/ECA protocol is better than the performance of CSMA/CA protocol." - Justify the claim with proper arguments. 8

4. a) Match the following to one or more layers of the TCP/IP protocol stack:
- i. reliable process-to-process message delivery
 - ii. route selection
 - iii. defines frames
 - iv. provides user services such as e-mail and file transfer
 - v. transmission of bit stream across physical medium

- b) Consider a wireless Personal Area Network (PAN) consisting of eight stations connected to the same wireless channel. All the eight stations employ Code-Division Multiple Access (CDMA), a multiple-access method in which the available bandwidth of a link is shared, among themselves through code. Each station is assigned a unique code, which is a sequence of numbers called chips, as shown in Table 2. 18

Table 2: Chip sequences assigned to different stations for Question (4.b)

Stations	Chip Sequences
S1	[+1 +1 +1 +1 +1 +1 +1 +1]
S2	[+1 -1 +1 -1 +1 -1 +1 -1]
S3	[+1 +1 -1 -1 +1 +1 -1 -1]
S4	[+1 -1 -1 +1 +1 -1 -1 +1]
S5	[+1 +1 +1 +1 -1 -1 -1 -1]
S6	[+1 -1 +1 -1 -1 +1 -1 +1]
S7	[+1 +1 -1 -1 -1 -1 +1 +1]
S8	[+1 -1 -1 +1 -1 +1 +1 -1]

Let each of the stations share the link during a 1-bit interval. Table 3 shows the transmission status of different stations in a 1-bit interval. For simplicity, we assume that all stations send the resulting sequences at the same time.

Table 3: Transmission status of different stations for Question (4.b)

Stations	Data Bit Transmitted
S1	1
S2	1
S3	1
S4	Silent
S5	1
S6	0
S7	1
S8	Silent

Here, Station S4 is silent and listening to station S1. For the given scenario, describe the steps employed by receiver Station S4 to successfully decode the transmitted bit by Station S1.

5. a) What is meant by ETX Routing Metric? Explain one of the limitations of ETX with the aid of an appropriate example. 10
- b) Find the path that **maximizes the Expected Transmission Time (ETT)** from **Station A** to **Station-F** in the given network topology depicted in Figure 1. Assume that the default packet size in the given network is 2 MB. Table 4 contains the values of different link parameters. 15

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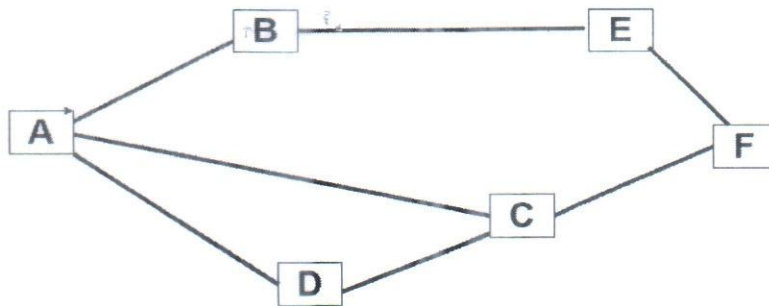


Figure 1: Network topology for Question (5.b) and (6.b)

Table 4: Link parameters for Question (5.b)

Link	Forward Delivery Ratio, R_{fwd}	Reverse Delivery Ratio, R_{rev}	Link Bandwidth, B (MB/S)
A—B	0.85	0.92	30
A—C	0.70	0.93	52
A—D	0.92	0.87	38
B—E	0.76	0.73	30
C—F	0.88	0.90	24
D—C	0.77	0.87	36
E—F	0.88	0.66	64

6. a) Describe Wastage Aware Routing in Energy Harvesting Wireless Sensor Networks (EH-WSNs). 6
- b) Consider the sample topology for an EH-WSN shown in Figure 1. Find the path that **maximizes** the **total residual network energy** for traffic generated from node A and destined for node F. 19

Table 5 and Table 6 contain the values of different nodal and network parameters. Assume, **B** is the maximum battery capacity of any node and ΔT is the time interval to predict the amount of energy harvesting and energy consumption.

Table 5: Nodal energy parameters for question 6.(b)

Node	Current Battery Level, E_p (Fraction of B)	Estimated Energy Harvest after ΔT time, E_h (Fraction of B)
A	0.90	0.15
B	0.93	0.17
C	0.77	0.21
D	0.92	0.12
E	0.89	0.20
F	0.77	0.18

Table 6: Link parameters for question 6.(b)

Link	Predicted Data Transmission Cost over ΔT time, E_c (Fraction of B)
A—B	0.06
A—C	0.11
A—D	0.14
B—E	0.15
C—F	0.11
D—C	0.08
E—F	0.09

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 4775: Introduction to Data Mining

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Calculate the **pair-wise item similarities** using the Pearson Correlation as the similarity measure when nearest neighbor, $N = 3$, based on the user-item rating matrix given in Table 1. 15
(CO2)
(PO1)

Table 1: User-item Rating Matrix for Question 1

User	Item		
	I1	I2	I3
U1	2	3	1
U2	5	3	3
U3	4	2	3
Alice	-	4	3

- b) Calculate the estimated rating of item I1 for Alice given in Table 1. 10
(CO2)
(PO1)
2. a) Considering the support threshold, $s = 50\%$, compute all frequent itemsets using the Apriori Algorithm for the dataset given in Table 2. Show the detailed process of your answer, including candidate itemsets generation and pruning. Explain when necessary. 15
(CO2)
(PO1)

Table 2: Dataset for Question 2

TransactionID	Items
T1	{1,2,4,6}
T2	{1,2,3,4,5}
T3	{1,2,3,5}
T4	{1,2,4}

- b) Based on the answer to Question 2. (a), figure out all the strong association rules (with support s , confidence c) for the frequent itemsets generated from Table 2, matching the following metarule, where X is a variable representing customers, and $item$ denotes variables representing items (e.g., "1," "2,"). Note that the minimum support, $s = 50\%$ and confidence, $c = 80\%$. 10
(CO2)
(PO1)

$$\forall x \in transaction, buys(x, item_1) \wedge buys(x, item_2) \Rightarrow buys(x, item_3) [s, c]$$

3. Elon Musk wants to design an efficient data warehouse to facilitate the analysis of Tesla's self-driving vehicles in an online analytical processing manner. Tesla registers huge amount of data related to each of its self-driving vehicles along several dimensions, such as, *Vehicle*, *Location*, *Speed*, *Fuel*, and *Time*. Each *Vehicle* is represented by information, such as, *vehicle_ID*, *vehicle_category*, *vehicle_name*, *driver_category*, etc., and each *Location* may be associated with a street in a city. For now, Elon wants to keep track of two measures: *vehicles_sold* and *vehicle_mileage*, where *vehicle_mileage* is the total number of miles a vehicle has covered.
- a) Design a data warehouse that satisfies Elon's requirements using a Star Schema. 10
(CO3)
(PO3)
- b) Hypothetically, if there were 5 levels of concept hierarchy per dimension (including *all*) in the data warehouse you designed in Question 3. (a), calculate the total number of cuboids that could be generated (including the base and apex cuboids). 5
(CO2)
(PO1)

- c) Starting from the base cuboid (*vehicle, location, speed, fuel, time*), point out the specific OLAP operations that should be performed in order to list the total milage covered by each vehicle type in each city in 2018 and 2020, where the fuel consumed per vehicle was more than 200L. 10
(CO2)
(PO1)
4. a) Assume that you are clustering 1 million points. Each point is represented by 3 integer attributes, and there will be 4 clusters. Determine the total main memory required for the following conditions: 7
(CO2)
(PO1)
- i. If you are using k-means algorithm for clustering
- ii. If you are using BFR algorithm for clustering
- b) Suppose you have the following three clusters in some dataset: 10
(CO2)
(PO1)
- Cluster1: (5, 7), (6, 9), (8, 12)
- Cluster 2: (12, 6), (14, 5), (15, 5)
- Cluster 3: (2,3), (0, 2), (3,1)
- Determine the summary of the clusters according to BFR algorithm.
- c) For a Mahalonobis acceptance criterion of $3\sqrt{d}$ (where d = number of dimensions), determine whether a new point (5, 1) belongs to any of the clusters mentioned in Question 4. (a) in the discard set, or whether it belongs to the retained set. 8
(CO2)
(PO1)
5. a) Write short notes on the following: 2+3+4
+5
(CO1)
(PO1)
- i. Parameter and Hyperparameter in a machine learning model
- ii. Soft margin and Hard margin in SVM
- iii. C and Gamma hyperparameter tuning in SVM
- iv. The purpose of kernel functions in SVM with example
- b) Explain how you would evaluate the performance of a classification model with example. 6
(CO2)
(PO1)
6. a) Model a C4.5 Decision Tree algorithm using the training data (RIDs 1 to 14) in the dataset shown in Table 3. Create a rough sketch of the obtained decision tree. 20
(CO3)
(PO3)

Table 3: Dataset for Question 6
(Training Set: RIDs 1 to 14, Testing Set: RIDs 15 to 18)

RID	Student_Status	Allowance	Owns_Console	Social_Life	Class: upgrades_pc_gpu
1	Junior	High	No	Fair	No
2	Junior	High	No	Very active	No
3	Sophomore	High	No	Fair	Yes
4	Senior	Medium	No	Fair	Yes
5	Senior	Low	Yes	Fair	Yes
6	Senior	Low	Yes	Very active	No
7	Sophomore	Low	Yes	Very active	Yes
8	Junior	Medium	No	Fair	No
9	Junior	Low	Yes	Fair	Yes
10	Senior	Medium	Yes	Fair	Yes
11	Junior	Medium	Yes	Very active	Yes
12	Sophomore	Medium	No	Very active	Yes
13	Sophomore	High	Yes	Fair	Yes
14	Senior	Medium	No	Very active	No
15	Junior	High	No	Fair	No
16	Sophomore	High	No	Fair	Yes
17	Senior	Low	Yes	Fair	Yes
18	Sophomore	Low	Yes	Very active	No

- b) Calculate the F1 score of your trained algorithm in question 6. (a) Using the testing set shown in Table 3 (RIDs 15 to 18). 5
(CO2)
(PO1)
- c) Explain how you would solve the problem of overfitting in a decision tree model. 5
(CO2)
(PO1)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 6147: Parallel & Distributed Computing

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 6 (six)** questions. Marks of each question are written in the right margin. The symbols have their usual meanings.

- 1. a) Distributed systems are often arranged to have a different layer of software that is logically placed on top of the respective operating systems of the machines that are part of the system to aid in the creation of distributed applications. This is referred to as *middleware*. When building a distributed system, what role does *middleware* play? 8
- b) In 1961, at the MIT Centennial, John McCarthy predicted that computers may one day be organized as a public utility, similar to the telephone system. Over the last three decades, conventional distributed systems have achieved enormous success, and now, cloud-based services are supplied as a computing utility. Analyze the evolution from mainframe computing to the Fog/Edge computing paradigm of the present day. 10
- c) With a P2P file sharing, what are the advantages for a query flooding system like Gnutella over a centralized query system like Napster? 7
- 2. a) Why was GFS developed when so many other file systems already existed? What prompted the development of such a file system? 7
- b) Imagine a Google file system instance configured to use the default of 3 replicas for each block. After a server fails, there will only be two replicas of many blocks. Joe claims that the Google file system can restore full redundancy of all blocks faster than would be the case with traditional 3-way replication (in which sets of three servers contain identical sets of blocks). Is he right? Explain your answer. 10
- c) Differentiate between availability and reliability. Is it possible to achieve 100 percent system availability? What measures must be taken to improve system availability and reliability? 8
- 3. a) Traditionally, supercomputers provide the high-performance computing (HPC) needed to solve large-scale scientific computing problems. Recent developments indicate that consumers demand a vast quantity of computational resources to execute large-scale deep learning models. However, supercomputing is quite costly in terms of acquiring vast computing resources. 5+5

- i. How can cloud and grid computing provide HPC services to end users to fill this void?
- ii. What challenges must be addressed to deliver HPC facilities through cloud computing?

b) When distributed systems are designed and engineered, certain fundamental properties have to be taken into account, including: 10

- i. concurrent execution of components
- ii. independent failure modes
- iii. communication delay
- iv. no global time

Give three examples of the implications of these properties (separately) on the engineering of large-scale, widely distributed systems.

c) What are the unique advantages offered by fog computing? 5

4. a) Three computers at IUT, A, B, and C communicate using a protocol that implements the idea of lamport clocks (they include their clock time stamp in messages). At the beginning of time, all three computers begin with their logical clock set to zero (0). Later, the following sequence of events occurs: 15

- A sends message M1 to B: "hi".
- After receiving M1, B sends message M2 to C: "A told me hi" .
- After receiving M2, C sends message M3 to A: "B is boring"

Indicate the time included with the messages as they are sent at each step.

- i. Send (M1, -)
- ii. Send (M2, -)
- iii. Send (M3, -)

b) Maintaining all clock states from the previous question 4. (a), three *additional* messages are sent: 10

- After receiving M3, A sends message M4 to B: "C is kind of random!"
- After receiving M4, B sends message M5 to A: "C is boring"
- A receives message M5

After all of these messages have been sent and received, what time does each computer think it is?

- 5. a) Consider the following event diagram shown in Figure 2 for processes P1, P2 and P3 executing in a distributed system. Compute the vector clock that is carried on each message 10

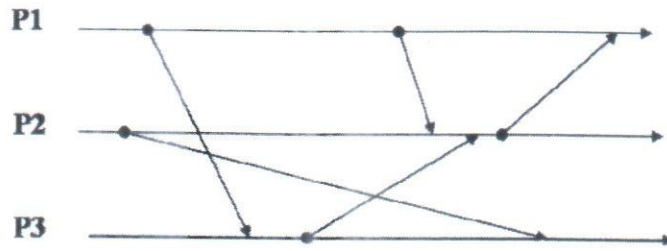


Figure 1: Diagram for question 5. (a)

- b) A client's clock reads 3:20:00. The server's clock reads 3:10:00 when they synchronize using the Berkeley algorithm. Assume message delays are negligible. What is the time at the client after synchronization? 10
- c) Compare between Spark and MapReduce. 5
- 6. a) You were just hired as an expert in Distributed System by a stream service provider firm that have won the bid for World Cup 2022 live match streaming. To upgrade their legacy system, they asked you to recommend a distributed framework among the technologies discussed in class. What framework would you suggest them after analyzing their requirements? Justify your answer. 10
- b) Decoupling the application software from the user greatly increases system throughput. Explain how your proposed framework in question 6. (a), decouples the application from the users. 8
- c) What is the purpose of CloudFront and Lambda in AWS? 7

**ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)**

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 6191: Web based Instruction and E-learning

Programmable calculators are not allowed. Do not write anything on the question paper.
There are 6 (six) questions. Answer all of them. Figures in the right margin indicate marks.

-
1. a) Materials developed for web-based instruction must follow established instructional design principles in order to be effective and viable means of education. List Gagné's nine universal steps of instruction and discuss how these nine steps can be incorporated into web-based courseware. 15
 - b) As an online course content developer how will you consider learning styles to designing courseware? 10
 2. a) What are the risks to bring a guest lecturer in an e-learning environment? How these risks can be controlled? 15
 - b) Discuss the benefits to bring a guest lecturer in a course. 10
 3. a) What are the criteria that you would follow to select a guest lecturer for an online course managed by you? Justify your answers. 13
 - b) Discuss the qualities which an online student should possess to achieve most out of e-learning. 12
 4. a) *"If teaching online is time consuming, this is because the absence of face-to-face contact with students requires instructors to respond to all inquiries in writing. It is for this reason that the very design of an online course needs to take into account a clear time frame for responding to students within the different areas of the course."* – explain this statement by providing response time-frame for various forms of communication in E-learning. 15
 - b) Write short notes on key elements of an online program. 10
 5. a) Among various education levels, three are primary, secondary and higher education. Discuss the challenges you might face to implement web based learning for students of these levels. 15
 - b) List the basic criteria for a person to be successful as an online facilitator with detail description. 10
 6. a) Instructional strategies are tools available to educators for designing and facilitate learning. Discuss some instructional strategies which have been effectively used in the traditional classroom and can likewise be used in the online learning environment too. 15
 - b) Discuss OCTR (*Orientation, Coaching, Tuning and Routinization*) model of learning. 10

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M.Sc.TE. (2-yr)

5 December 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 6197: Distributed and Parallel Computing

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 6 (six)** questions. Marks of each question are written in the right margin. The symbols have their usual meanings.

1. a) Distributed systems are often arranged to have a different layer of software that is logically placed on top of the respective operating systems of the machines that are part of the system to aid in the creation of distributed applications. This is referred to as *middleware*. When building a distributed system, what role does *middleware* play? 8
- b) In 1961, at the MIT Centennial, John McCarthy predicted that computers may one day be organized as a public utility, similar to the telephone system. Over the last three decades, conventional distributed systems have achieved enormous success, and now, cloud-based services are supplied as a computing utility. Analyze the evolution from mainframe computing to the Fog/Edge computing paradigm of the present day. 10
- c) With a P2P file sharing, what are the advantages for a query flooding system like Gnutella over a centralized query system like Napster? 7
2. a) Why was Google file system (GFS) developed when so many other file systems already existed? What prompted the development of such a file system? 7
- b) Imagine a Google file system instance configured to use the default of 3 replicas for each block. After a server fails, there will only be two replicas of many blocks. Joe claims that the Google file system can restore full redundancy of all blocks faster than would be the case with traditional 3-way replication (in which sets of three servers contain identical sets of blocks). Is he right? Explain your answer. 10
- c) Differentiate between availability and reliability. Is it possible to achieve 100 percent system availability? What measures must be taken to improve system availability and reliability? 8
3. a) Traditionally, supercomputers provide the high-performance computing (HPC) needed to solve large-scale scientific computing problems. Recent developments indicate that consumers demand a vast quantity of computational resources to execute large-scale deep learning models. However, supercomputing is quite costly in terms of acquiring vast computing resources. 5+5

- i. How can cloud and grid computing provide HPC services to end users to fill this void?
- ii. What challenges must be addressed to deliver HPC facilities through cloud computing?

b) When distributed systems are designed and engineered, certain fundamental properties have to be taken into account, including: 10

- i. concurrent execution of components
- ii. independent failure modes
- iii. communication delay
- iv. no global time

Give three examples of the implications of these properties (separately) on the engineering of large-scale, widely distributed systems.

c) What are the unique advantages offered by fog computing? 5

4. a) Three computers at IUT, A, B, and C communicate using a protocol that implements the idea of lamport clocks (they include their clock time stamp in messages). At the beginning of time, all three computers begin with their logical clock set to zero (0). Later, the following sequence of events occurs: 15

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- After receiving M1, B sends message M2 to C: "A told me hi"
- After receiving M2, C sends message M3 to A: "B is boring"

Indicate the time included with the messages as they are sent at each step.

- i. Send (M1, -)
- ii. Send (M2, -)
- iii. Send (M3, -)

b) Maintaining all clock states from the previous question 4. (a), three *additional* messages are sent: 10

- After receiving M3, A sends message M4 to B: "C is kind of random!"
- After receiving M4, B sends message M5 to A: "C is boring"
- A receives message M5

After all of these messages have been sent and received, what time does each computer think it is?

5. a) Consider the following event diagram shown in Figure 2 for processes P1, P2 and P3 executing in a distributed system. Compute the vector clock that is carried on each message

10

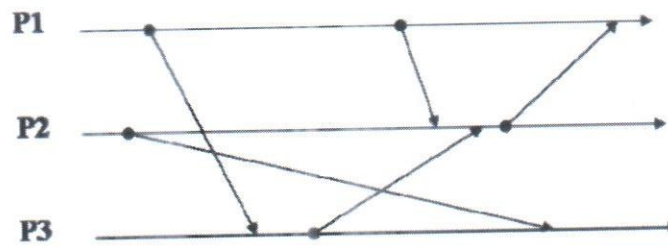


Figure 1: Diagram for question 5. (a)

- b) A client's clock reads 3:20:00. The server's clock reads 3:10:00 when they synchronize using the Berkeley algorithm. Assume message delays are negligible. What is the time at the client after synchronization?
- c) Compare between Spark and MapReduce.
6. a) You were just hired as an expert in Distributed System by a stream service provider firm that have won the bid for World Cup 2022 live match streaming. To upgrade their legacy system, they asked you to recommend a distributed framework among the technologies discussed in class. What framework would you suggest them after analyzing their requirements? Justify your answer.
- b) Decoupling the application software from the user greatly increases system throughput. Explain how your proposed framework in question 6. (a), decouples the application from the users.
- c) What is the purpose of CloudFront and Lambda in AWS?

10

5

10

8

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**ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)**

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 6265: Advanced Image Processing

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **6 (six)** questions. Marks of each question are written in the right margin.

1. a) Consider the 8-bit gray scale images $f(x,y)$ and $g(x,y)$, whose intensity levels range from 0 ~ 255, and they are of the same size, $M \times N$ pixels. If one image is repeatedly subtracted from another image multiple times, then how will the final image look like after 256 subtractions? Assume any negative values are clipped to zero after each subtraction. 10
- b) What is the problem of detecting edges in color images using channel-wise gradients? How can you solve this problem? 10
- c) Why is there a Black Channel in the CMYK color model? 5
2. a) Show the validity of the duality expression: $(A \ominus B)^c = (A^c \bullet \hat{B})$ 5
- b) Three features (lake, bay, and line segment) are useful for differentiating thinned objects in an image shown in Figure 1. Develop a morphological/logical algorithm for differentiating among these shapes. The input to your algorithm would be one of these three shapes. The output must be the identity of the input. You may assume that the features are 1 pixel thick and that each is fully connected. However, they can appear in any orientation. 3×5

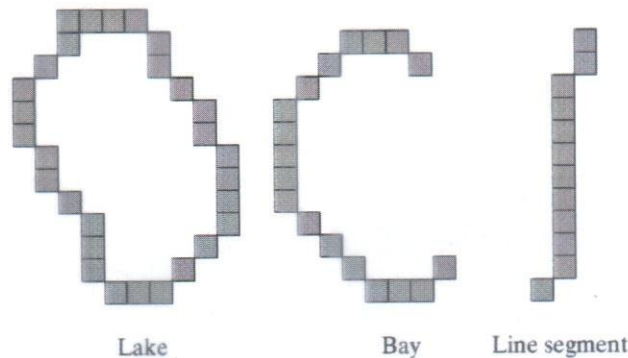


Figure 1: Figure for question 2(b).

- c) Simplify the hit-or-miss transform's morphological expression for a structuring element which contains a combination of 1s and 0s. 5
3. a) A skilled medical technician is assigned with the job of inspecting a certain class of images generated by an electron microscope. In order to simplify the inspection task, the technician decides to use image enhancement. When examining a set of representative images he finds the following problems: 5×4
 - i. Bright isolated dots that are of no interest
 - ii. Lack of sharpness
 - iii. Not enough contrast in some images

- iv. Shifts in average gray level value – the value should be K to perform correctly for certain intensity measurements
- v. The technician wants to correct these problems and then color all gray levels in the range $[I_1, I_2]$ in full white, while keeping other gray levels unchanged.

Propose a sequence of processing steps that the technician can follow to achieve the desired goal.

- b) Assume the Sobel masks are used to obtain G_x and G_y . Prove that in this case the gradient computed by $\nabla f = \sqrt{G_x^2 + G_y^2}$ and $\nabla f = |G_x| + |G_y|$ give identical results for edges oriented in the horizontal and vertical directions. 5
- 4. a) Mathematically show that you can compute the 2D Fourier Transform by first computing a 1D Fourier transform along the individual rows of an input image, followed by performing another 1D Fourier transform along the columns of the results from the first transform output. 8
- b) Consider the two images given in Figure 2. 7

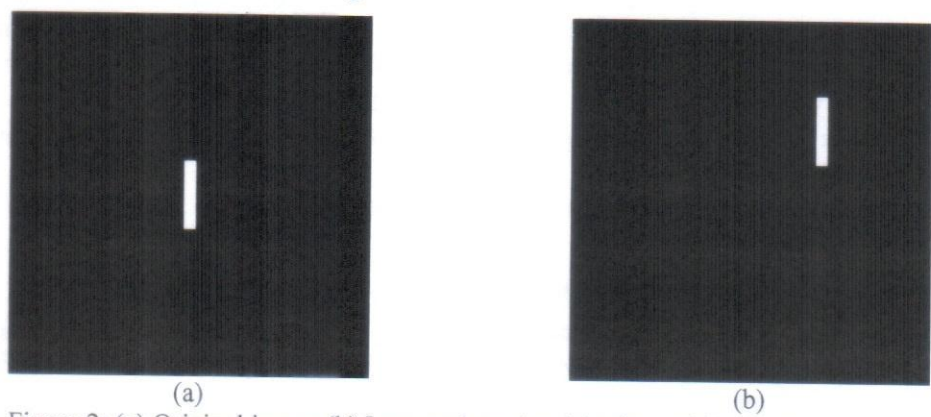


Figure 2: (a) Original image (b) Image where the object's position has been shifted.

The spectrum values of the DFT $F(u,v)$ of the above two images will be identical. In other words, magnitude of $F(u,v)$ is independent of translation. However, the Fourier values will be different. Explain this difference with mathematical equations of Fourier Transform.

- c) Figure 3 shows an image and its Fourier spectrum. What is the source of the nearly periodic bright points in the horizontal axis of the spectrum? Explain why it occurred. 3+7

Note: Ignore the various circular cutoff frequency contours.

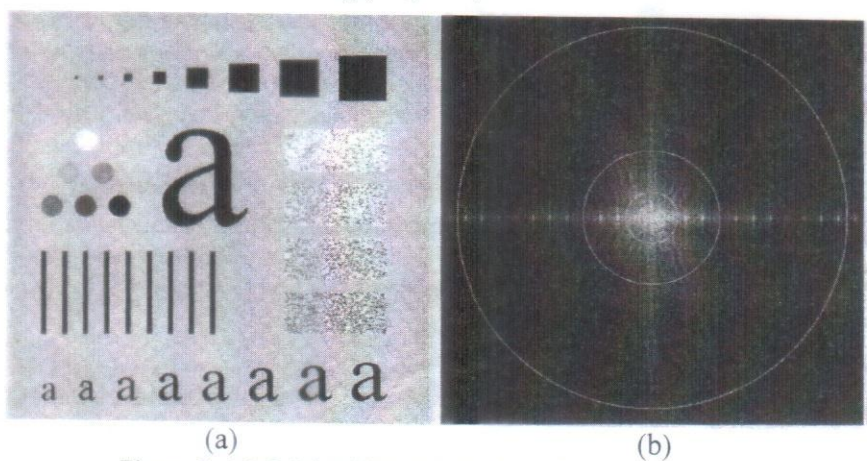


Figure 3: (a) Original image and (b) its Fourier spectrum.

- 5. a) Design a filter in the Frequency Domain which can be applied to give you the output equivalent to applying a Laplacian of Gaussian (LoG) filter in the Spatial Domain. 7

- b) Design a system for decoding the prediction residual pyramid generated by the encoder as given in Figure 4, and draw its block diagram. Assume that there is no quantization error introduced by the encoder. 8

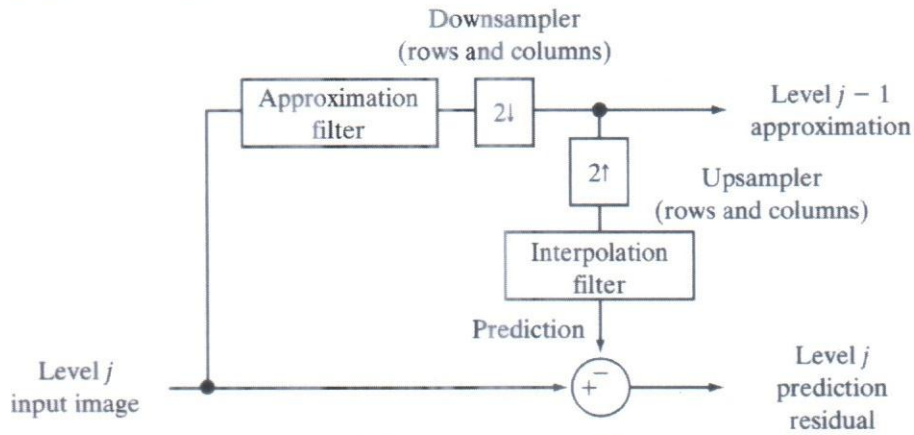


Figure 4: Figure for question 5(b)

- c) Given the sequence $f(n) = \{0, 3, 1, -2\}$ where $n = 0, 1, 2, 3$, compute following sequences. 5×2
- i. The sign-reversed sequence.
 - ii. The order-reversed sequence.
 - iii. The modulated sequence.
 - iv. The modulated and then order-reversed sequence.
 - v. The order-reversed and then modulated sequence.

6. a) Given the synthesis filter $g_0(n) = \left\{ \frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}} \right\}$, generate the perfect reconstruction filter banks. With these filter banks, show that they satisfy the orthonormality conditions. 5+5
- b) Using the filters in Question 6. (a), draw the block diagram to reconstruct the input $f(m, n)$ with four-band filter bank decoder. 8
- c) A wavelet packet decomposition of the Vase image is shown in Figure 5. Draw the corresponding decomposition analysis tree, labeling all nodes with the names of the proper scaling and wavelet spaces. 7

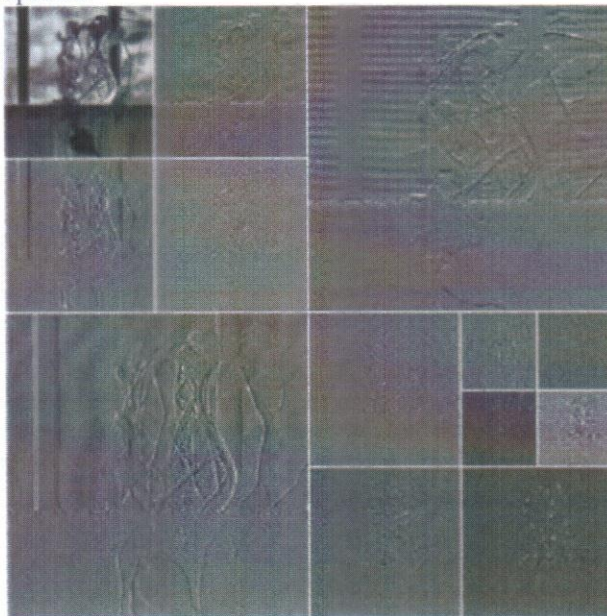


Figure 5: Figure for question 6(c)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2021-2022

DURATION: 3 HOURS

FULL MARKS: 150

CSE 6275: Advanced Human Computer Interaction

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all the 6 (six)** questions. Marks of each question are written in the right margin.

1. Google Maps is one of the top most apps used for online navigation. Google Maps designs its affordances for the user to interact with a certain, perhaps playful, attitude. Google Timeline, Google Local Guides and Google Earth thus contain affordances that allow for a certain interaction, in order for it to be used for a different purposes. Google Timeline could be seen as a take-over of an analogue diary, Google Local Guides serves as a social network and Google Earth shows similarities to a travel guide.
 - a) For each of Norman's design principles (Visibility, Feedback, Mapping, Constraints), write how the Google Map uses the principles for effective design. 10
 - b) How do the affordances of Google Maps allow for a playful interaction and how do they show that the real world and the online world are interwoven? 10
 - c) "A great User Experience is compromised by a lack of Usability." – Justify this assertion. 5

2.
 - a) Explain the relationships among mental model, metaphor, and conceptual model with examples. 10
 - b) Suppose you have an idea for a system, and you know what you want it to do in the real world. Now you need to communicate the idea to your teammates. So you have the tool named 'Conceptual model' to communicate your design ideas based on:
 - Entities – The people, places, and things.
 - Relationships – How the entities interact with one another.
 - Constraints – The number of entities interacting.
 Find out and explain the conceptual models based on activities used in the Google Map app described in the scenario of Question 1. 10
 - c) Briefly explain the Star lifecycle model as a process of interaction design. 5

3. **Case Study A:**

Children with Down Syndrome (DS) may suffer from an intellectual disability as well as physical and social disability. Physical disability falls into two categories, fine motor skill (e.g. picking, grasping, holding small objects - that use the small muscles of the fingers, toes, wrists, lips, and tongue) and gross motor skill (e.g. walking, kicking, jumping, and climbing stairs - that use the large muscles in the arms, legs, torso, and feet) deficiency.

Research shows that Game Therapy has a positive effect on improving the motor skills of children with DS. Suppose you have to conduct a research and design a game therapy system for the children with DS to improve gross motor skills.

 - a) Describe how you are going to identify the list of requirements of the system. Which data gathering technique will you follow? Give justification with the help of examples. 8
 - b) Write at least two measurable usability requirements for each of the following usability goals: 10
 - i. Having good utility
 - ii. Effectiveness
 - iii. Efficiency
 - c) How will you represent those requirements to your teammates for analysis? Give example. 7

- 4. a) Suppose you have to apply User-Centered Design (UCD) approach to the project described in the **Case Study A**. Answer the followings:
 - i. Define UCD. 3
 - ii. Describe how you will follow each stage of the UCD approach. 10
- b) Briefly describe how you will generate alternate design solutions for the case study A and on which basis you will choose among the alternatives. 10
- c) What is usability engineering? 2

- 5. a) Which prototyping technique will you follow for the system explained in the **Case Study A**? Explain why. 8
- b) Construct a low-fidelity prototype for the system using an appropriate prototyping technique for the scenario in **Case Study A**. 10
- c) Write one main persona and corresponding scenario capturing how the user is expected to interact with the system as described in **Case Study A**. 7

- 6. a) Suppose you as a researcher want to investigate whether males or females are more adept at texting, the experiment probably involves entering text messages on a mobile phone. For the experiment answer the followings:
 - i. What are the independent variables and confounding variables you would test? Explain with justification. 5
 - ii. Explain how you would conduct between-subjects and within-subject experiment. 5
- b) Choose an appropriate evaluation method for each of the following cases with one sentence justification. 10
 - i. You have designed and implemented a new game system and want to evaluate it before release.
 - ii. You are at an early stage in the design of a spreadsheet package and you wish to test what type of icons will be easiest to learn.
- c) Write an example application scenario where you can use Augmented Reality (AR)/ Virtual Reality (VR) technologies in the field of (Computer-Supported Collaborative Works (CSCW). 5

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

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