

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

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2018-2019

DURATION: 3 Hours

FULL MARKS: 150

SWE 4101: Introduction to Software Engineering

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

There are 8 (eight) questions. Answer any 6 (six) of them.

Figures in the right margin indicate marks.

1. a) Logic programming is not only used in computers but also in other devices. Give two specific examples (with their programming details) where programming enables the functionality of the devices. 6
- b) A novice user used the commands *ls* and *cd* as shown in the following figure and got a message: 'Error: not a directory'. 6

```
# ls
user      bin      etc      home      dev      var      myfileDirDev
# cd myfileDirDev
Error: not a directory
```

What mistake has s/he done? What actions does the user need to perform if s/he wants to investigate the contents of *myfileDirDev*?

- c) Definition and realization of *Pixel* is the fundamental issue in any display technology. How is a *Pixel* defined in CRT, LCD and LED technologies? 6
- d) What are the components of a computer system? Briefly describe them. 7
2. a) What is a software process? 5
- b) Briefly describe waterfall software development process. 10
- c) Briefly describe the salient features of SCRUM process. 10
3. a) How does agile practitioners involve customers with the software project? 6
- b) Prototyping is an approach used to understand the customer requirements. How can prototyping help in waterfall development and in agile XP? 6
- c) What is Continuous Integration (CI)? How do big companies perform CI in their premises? 6
- d) The cost of requirement change increases rapidly (sometimes exponentially) with respect to time elapsed in a project. How does agile practice reduce the cost of change? 7
4. a) Write the differences between a compiler and an IDE. 5
- b) How do a compiler, linker and an assembler together generate an executable? 7
- c) What is a process within the operating system? How are the library references resolved in different stages of a program execution? 7
- d) Binary systems start with *bit* and then to *byte* and *kilobyte* and so on. Write all the quantities of the binary number systems and show their equivalence in decimal numbers. 6

5. a) Blue Ray, DVD and CD-ROM have same or similar technologies yet they are packaged differently. How does the capacity of the optical disks extended from CD-ROM to DVD and to blue ray? 7
- b) Most of the storage devices are electro-mechanical. However, biological storage and computation are possibilities and are being researched. Briefly describe a hypothetical scheme of using biological molecule as a storage bit. 6
- c) How does flash memory technology represent a *bit* of storage? 6
- d) 'Flash memory write must do erase of the bit or a block of memory before writing the content'- This is an overhead. Why does the flash memory technology necessitate the erase cycle? 6
6. a) If you are asked to control a bicycle with a remote control, how will you augment the cycle with electronics, motors, actuators and sensors to accomplish the task? You may draw diagrams if necessary. 7
- b) Suppose a hypothetical micro-processor has the following instructions with their instruction codes: 6

Instruction	Instruction Code (in Hexadecimal)
COC	55
DIB	9F
BAB	43

The instructions use some registers AX - FX which have codes 00-05H. The instructions can also use one numeral.

What will be the machine code for the following micro-processor commands:

COC AX, FX
DIB FX, 89H
BAB BX, DX

- c) How is a URL resolved when you type it on the browsers address bar? 6
- d) Briefly describe the request/response protocol of World Wide Web (WWW). 6
7. a) Write an algorithm to convert a decimal number D to a base B number system. 6
- b) Perform the following 2's complement arithmetic assuming 4-bit computer system. Also indicate whether the arithmetic is correct or not. 9
- i. 6 - 3
 - ii. -4 -5
 - iii. -4-4
- c) Convert $(66)_{10}$ to a 6
 - i. Base-4 number.
 - ii. Base-3 number.
- d) What are the decimal values for the numbers $(112)_5$ and $(665)_7$? 4
8. a) A file has a permission 0755 (111 101 101 in binary) set by its owner. What does it imply? Which types of files have this sort of permission? 7
- b) Briefly describe SaaS and IaaS with examples. 6
- c) How does the operating system manage the CPU and share it with multiple competing processes? 6
- d) Now a days many I/O Devices function as both input and output devices. Give 3 (three) examples of such integrated I/O devices with their functionalities. 6

Library

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WINTER SEMESTER, 2018-2019

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FULL MARKS: 150

CSE 4105: Computing for Engineers

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- | Instruction | Instruction Code
(in Hexadecimal) |
|-------------|--------------------------------------|
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- The instructions use some registers AX - FX which have codes 00-05H. The instructions can also use one numeral.
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- | |
|-------------|
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 - 4 - 4
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SEMESTER FINAL EXAMINATION

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DURATION: 3 Hours

FULL MARKS: 150

CSE 4107: Structured Programming I

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

There are 8 (eight) questions. Answer any 6 (six) of them.

Figures in the right margin indicate marks.

1. a) What is Dynamic Memory Allocation (DMA)? Why do we need DMA? 6
 b) Write a C program which allocates memory during runtime. The program will take an integer as input, each time the integer is positive, the previous memory will be freed and a new memory (size will be the given integer) will be allocated for the same pointer. The program will free all memory and terminate if a negative integer is given as input. 12
 c) Read the following codes and describe the process of memory allocation in both the cases. 7

```
int *arr = malloc(40);
int a = 2, b = 7;
for(int i=0; i<5; i++) arr[i]=i;
arr = malloc(20);
```

Figure 1(a): Code for 1(c)

```
int *arr = malloc(40);
int a = 2, b = 7;
for(int i=0; i<5; i++) arr[i]=i;
arr = malloc(80);
```

Figure 1(b): Code for 1(c)

2. a) Why are preprocessors called “ preprocessors”? 5
 b) What are function like macros? Convert the following functions into function-like-macros and use them in the main function. 11

```
float form(int a, int b)
{
    float c = a+b;
    float d = a-b;
    c = c*c; d = d*d;
    return sqrt(c+d);
}
```

Figure 2(a): Code for 2(b)

```
int mul(int a, int b)
{
    int c;
    c = a*b;
    return c;
}
```

Figure 2(b): Code for 2(b)

```
float div(int a, int b)
{
    float c, d;
    c = a; d = b;
    return c/d;
}
```

Figure 2(c): Code for 2(b)

- c) Write a program which handles different debugging scenarios using conditional compilation. The program will take a string, an integer, and a double as input consecutively. Each input will be printed when the debugging mode is on (DEBUG is defined), and nothing will be printed otherwise (DEBUG is not defined). 9
 3. a) In the programming language C, reading from and writing to files must be handled with caution as they can cause irreparable damage to the machine. If so, is figure 3 the proper way to handle files? Justify your answer in terms of Dynamic Memory Allocation mechanisms. 10

```

int main()
{
    FILE *fp, *fp1;
    fp = fopen("in.txt", "r");
    char ch[100];
    fgets(ch, 100, fp);
    fputs(ch, fp);
}

```

Figure 3: Sample code for question 3(a)

- b) The given text file has several entries of student information (student name, student ID, total marks) for the course CSE 4107. Create a structure to hold this information, read from the file, and sort the student information according to student ID. 15

Saqib Iritza 144431 245	Mohammad Shihab Rashid 144407 210	Md Bakhtiar Hasan 144401 280
Sadaf Md Halim 144422 160	Mohsinul Kabir 144414 230	

Figure 4: Sample text file for question 3(b). The file name is “database.txt” and the format of the texts will always be the same. However, the contents of the file may change. The three images are the continuation of the same text file and are consecutive.

4. a) “A file can be opened in different modes – ‘r’, ‘w’, ‘a’, etc., using a character stream.” 9
 Explain the mentioned modes with differences.
- b) Why do we need binary stream? Show reasons in contrast to character stream. 8
- c) Write a C program which reciprocates the “copy” action of windows. Take the file name as input from the console and keep the file name same. (Hint: The program should be able to copy any kind of file.) 8
5. a) Sabbir is a customer-manager in a company. Each time a customer calls he has to manually find the customers details over the phone. He wants to automate the information of customers using a C program. Create the necessary structure for the system and take input from the console using the structure. Each customer has the following information attached to him/her:
Customer:
 i. Name (char)
 ii. ID (number)
 iii. Address (character)
 iv. previous transaction in taka (real number)
 v. mobile number (character)
 vi. emergency contact person (must also be a customer) 12
- b) What is the difference between a **structure** and a **union**? 5
- c) Why do we use bit-fields? When is using a bit-field actually effective if word size is 4 bytes? 8
6. a) What is the difference between a **while** loop and a **do while** loop? Explain. 6

- b) Write down the output of the following program:

11

```

int main()
{
    int i, j, k;
    for(i=0, j=0; i<5, j<5; i++, ++j){
        printf("Inside for loop %d %d\n", i, j);
    }
    while(++i<12 && j++<12){
        printf("Inside while loop %d %d\n", i, j);
        for(k=0; k<3; ++k, i++, ++j){
            printf("Inside nested for loop %d %d %d\n", i, j,
k);
        }
    }
    return 0;
}

```

Figure 5: Code for question 6.b)

- c) Write a C program which prints the number table of **n** numbers upto **m** multiples. There will be $6 (3 \times 2)$ lines of output for a pair of input (**n** and **m**). In a general case, the output will contain $m \times n$ lines in total. The sample input and output is given below:

8

Table 1: Number table sample for question 6(c)	
Sample Input	Sample Output
3 2	1 * 1 = 1 1 * 2 = 2 2 * 1 = 2 2 * 2 = 4 3 * 1 = 3 3 * 2 = 6

7. a) Classify the following C program into their appropriate C token (identifier, keyword, constant, etc.). Each part of the program must fall under a category.

9

```

int main()
{
    int a, b, c;
    scanf("%d %d", &a, &b);
    c = a + b;
    return 0;
}

```

- b) Write short notes on the following topics:
- Unary and Binary Operators
 - Assignment Operators
 - Bitwise Operators
 - Structured Programming

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8. a) What are the three levels of languages in programming? Briefly explain each one.
- b) How is a High-level language converted to Machine Language? Describe the process and mention the product of each step.
- c) What are the rules that identifiers must follow? What is type-casting and why it is needed?

6

10

9

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There are **8 (eight)** questions. Answer any **6 (six)** of them.

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1. a) Write down the output of the following code:

10

```
#include <stdio.h>

int main() {
    int a[10]={10,9,8,7,6,5,4,3,2,1};
    int *p1,t,u,v,w,x,y,z;
    p1=a;
    t=(*p1)++;
    u=++(*p1);
    v=*p1;
    w=*>+p1;
    x=*>p1++;
    y=*>(>p1);
    z=*>(p1+1);
    printf("%d %d %d %d %d %d",t,u,v,w,x,y,z);
    return 0;
}
```

Figure 1: Code segment for Question 1(a)

- b) Write a user-defined function that takes three integer arrays as parameters. Now merge and sort the 1st and 2nd array to the third array. Remove the repeating number from the array. 10
- c) Explain two types of data type conversion (Implicit and Explicit) in C with suitable example. 5
2. a) Write a C program that takes an integer n as an input from the user and displays each digit of that integer in English. So, if the user types 932, the program should display “nine three two”. Remember to display “zero” if the user types just a 0. You have to print the output in a user defined function. **You are not allowed to write any printf statement in main function.** 12
- b) You will be given a decimal number. You will have to convert it to its ternary (Base 3) equivalent by writing a C program. 8

Sample Input	Sample Output
10	101
100	10201
1000	1101001

Figure 2: Sample output for Question 2(b)

- c) What is a comment in C? Give examples of two style of commenting. How compilers execute a comment in C? 5
3. a) Assume that you are given an array of integer in an arbitrary order. Write a recursive solution to find out the maximum value in that array. Do not declare any global variable or array. In the given sample input 5 indicates that 5 integers will be in that array. After that user will give 5 integers as input. 10

Sample Input	Sample Output
5 5 4 9 10 3	10

Figure 3: Sample output for Question 3(a)

- b) Write a C program that prints its own source code in the console. 10
 c) Give examples of using fscanf() and fprintf() function to take input from keyboard and show 5
 output on console.

4. a) Write down the output of the following code 12

```
#include<stdio.h>
int main(){
    // 'A' : 65
    int a='E',b,i;
    for(i='A';i<a;++i){
        b=i%12;
        while(b>0){
            if(b--%4){
                printf("%d ",i%2?i:b);
                continue;
            }
            if(--b%2){
                printf("%d ",i%2?i:b);
            }
            b--;
        }
        printf("\n");
    }
    return 0;
}
```

Figure 4: Code Segment for Question 4(a)

- b) Write a program that copies a text file. Specify both the source and destination file names on the 8
 command line. Use fgets() and fputs() to copy the file. Include full **error checking**.
 c) What is a compile-time operator? Explain with necessary example. 5

5. a) Write a C program that takes an integer (the key). Your program should shift the characters a-z 12
 and A-Z in the file named as "original" by the key and account for "roll-around" at the end of the
 alphabet. The key can be from 0 to 25. Write the results to a new file called encrypted.

Example:

mytextfile: This is the end of z key: 2	encrypted: Vjku ku vjg gpf qh b
--	--

Explanation: First letter T is converted to ('T'+2) that is V. As well as the last letter z is converted to b as ('z'+2) is b if we consider the roll-around.

- b) Write a user defined function that will take a $3 \times 3 \times 3$ three dimensional array as a parameter and 6
 return the summation of all the elements in the array.
 c) Explain four storage class classifiers with their uses in suitable scenario. 7
6. a) What are the bitwise operators in C? Assume that two character variables **a** and **b** have the value 10
 65 and 91 respectively. What will be the resultant after each bitwise operation is done on **a** and **b**.

- b) The following code in figure 5 contains some errors. Try to find out those errors and write down the correct code: 8

```
#include <stdio.h>

int main()
{
    int a[], b[5+4], c[3, 3]
    for(i=0; i=<5; i++)
    {
        b[i]=i
        a[i]=i
        c[i][i]=i
    }
    return 'a'
}
```

Figure 5: Code Segment for Question 6 (b)

- c) What is **union** in C? Show how it is declared and how it appears in memory with necessary diagram. 7
7. a) Write a C program to carry out the following: (Assume that words are separated by space in the file.) 10
- Read a text file “input.txt”
 - Print each word in reverse order
- Input:** BANGLADESH IS MY COUNTRY
Output: HSEDALGNAB SI YM YRTNUOC
- b) Write a C program for the following scenario. User will give a string as input. Your program should convert all the uppercase letter to lowercase letter and all lowercase to uppercase letter and print in the console. 8
- c) Write a C program to find the size of a text file without traversing it character by character. 7
8. An intra IUT street football tournament will be held on 20th May, 2019. Total 20 teams are participating in this tournament. We want to store the tournament information in C program. We need to store:
- Team Name [Maximum 30 character]
 - Number of match played (integer value)
 - Total no of wins (integer value)
 - Total Points (integer value)
 - Information about team members.
- Each team consists of 5 members. One goal keeper, two defenders and two striker. The information about the team members are:
- Name (Maximum 50 characters)
 - Player Type (integer value USE Macro TYPE_KPR, TYPE_DEF, TYPE_STRKR)
 - Score (integer value)
- a) Now create a structure and declare a variable of that structure so that we can store the above information. You may need nested structure to store all the information. Also mention the total size of your structure with a diagram. 6
- b) Write a User defined function to print all the team names with total no of wins and total points. In case of printing, the number of wins will get the highest priority. If there is a tie then check who gets the higher points. If both are same then print the team names in alphabetical order. 12
- c) Write a user defined function which will take all the team information as a parameter and print the best scorers (1st, 2nd and 3rd) among all the team along with their team name. 7

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Math 4141: Geometry and Differential Calculus

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There are **8 (eight)** questions. Answer any **6 (four)** of them.

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1. a) State Sandwich Theorem. Find the following limits using this theorem: 12

i. $\lim_{x \rightarrow 0} x^2 \sin \frac{1}{x}$ ii. $\lim_{x \rightarrow 0} x^2 \cos\left(\frac{1}{x^2}\right)$

- b) Define horizontal and vertical asymptote. Use limit to determine all horizontal asymptotes from followings : 12

i. $F(x) = 2 + \frac{\sin x}{x}$ ii. $h(x) = \frac{\sqrt{x^2 + 4}}{x}$

- c) For which values of a and b is the following function continuous everywhere? 9.33

$$g(x) = \begin{cases} ax + 2b & \text{for } x \leq 0 \\ x^2 + 3a - b & \text{for } 0 < x \leq 2 \\ 3x - 5 & \text{for } x > 2 \end{cases}$$

Also graph the function.

2. a) Let $g(x) = x^2 - 4x$ 12

- i. Find the value of x for which the tangent line to $y = g(x)$ has slope equal to 6.
ii. Find the value of $g(x)$ at the point where the tangent line to $y = g(x)$ is parallel to $y = 2x + 5$.
iii. Find a value of x so that the instantaneous rate of change of g at x is equal to the average rate of change of g from $x = -1$ to $x = 3$.

- b) Where is the function $h(x) = |x - 1| + |x + 2|$ differentiable? Graph the function $h(x)$ and $h'(x)$. 12

- c) Does the graph $f(x) = \begin{cases} -1, & x < 0 \\ 0, & x = 0 \\ 1, & x > 0 \end{cases}$ have the vertical tangent at the origin? Give reason for 9.33
your answer.

3. a) The position function $s = f(t) = t^3 - 6t^2 + 7t$ of an object moving along the s- axis as a function of time t . Graph f together with the velocity function and acceleration function, and answer the followings: 12

- i. When is the object momentarily at rest? ii. When does it change direction?
iii. When is the particle moving forward? Moving backward?
iv. When does it speed up and slow down? v. When is it moving fastest (highest speed)?

- b) Find the equation of all tangent to the curve $y = \cos(x + y)$, $-2\pi \leq x \leq 2\pi$ that are 12 parallel to the line $x + 2y = 0$

- c) i. If $y \sin\left(\frac{1}{y}\right) = 1 - xy$, find $\frac{dy}{dx}$ ii. If $y = \left(1 + \tan^4\left(\frac{t}{12}\right)\right)^3$, find $\frac{dy}{dt}$ 9.33
- 4 a) A water tank has the shape of an inverted circular cone with base radius two meter and height 4 m. If water is being pumped into the tank at the rate of $2 \text{ m}^3/\text{min}$, find the rate at which the water level is rising when the water is 3 m. deep. 12
- b) Suppose that an object attached to a spring is pulled down a distance of 10 inches from its rest position and then released. If the time of oscillation is 3 second then develop a model that relates the displacement of object from its rest position after time t. Find the velocity function and discussed the motion of attached object. 10
- c) Find the equation of tangent and normal to the curve $y(x-2)(x-3) - x + 7 = 0$ at the point where the curve intersect the x axis. 11.33
- 5 a) Define extreme values of a function. Find the extreme values (absolute or local), if any, and where they occurs for the following functions: 18
- i. $f(x) = x^3(x-5)^2$ ii. $f(x) = |x - 5|, 4 \leq x \leq 7$.
- b) Write the statement of the Mean-Value theorem with its physical significance. Explain that the Rolle's theorem is a special case of Mean-Value theorem. Verify it for the function $f(x) = \begin{cases} x^3, & -2 \leq x \leq 0 \\ x^2, & 0 < x \leq 2 \end{cases}$ 15.33
- 6 a) Define monotonic function. Write the first derivative test for monotonic function. For the function $(x) = 3x - 12\sqrt{x}$, find the intervals on which the function is increasing or decreasing and then find the local maximum or minimum values, if any. Finally draw the graph using these behaviors. 20
- b) Write the statement of second derivative test for local extrema of a function. Discuss the concavity of the function $f(x) = \frac{3}{4}(x^2 - 1)^{2/3}$ and find the inflection point. Also find the local maximum or minimum values. 13.33
7. a) Using L'Hopital's rule, evaluate the following: 18
- i. $\lim_{x \rightarrow 1^+} \left(\frac{1}{x-1} - \frac{1}{\ln x} \right)$, ii. $\lim_{x \rightarrow \frac{\pi}{2}^-} \left(\frac{\pi}{2} - x \right) \tan x$, iii. $\lim_{x \rightarrow 0^+} \left(1 + \frac{1}{x} \right)^x$
- b) Suppose that the revenue and cost functions of a company in Gazipur city are given by $r(x) = 6x$ and $c(x) = x^3 - 6x^2 + 15x$ respectively. Is there any production level that maximizes profit or loss? If so, what is it? 15.33
8. a) If a line makes angles α, β , and γ with x, y and z axes respectively then show that $\sin^2\alpha + \sin^2\beta + \sin^2\gamma = 2$. 10
- b) Find the equation of the plane which passes through the point $(2, 3, -1)$ and parallel to the given plane $3x - 4y + 7z = 0$. Then find the distance between two planes. 13.33
- c) Find the volume of the tetrahedron formed by the four planes $x + y = 0, y + z = 0, z + x = 0$, and $x + y + z = 1$. 10

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

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2018-2019

DURATION: 3 Hours

FULL MARKS: 150

Phy 4141: Physics

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

There are 8 (eight) questions. Answer any 6 (six) of them.

Figures in the right margin indicate marks.

1. a) Discuss charge and matter in electrostatics. With the help of a suitable example show that electric charge is quantized and conserved. 7
- b) Distinguish electric flux, magnetic flux and the gravitational flux. Derive Coulombs law from Gauss's law. Apply Gauss's law to calculate the electric field just above an infinite sheet of charge and an insulated charged conductor. 10
- c) Protons in the cosmic rays strike the earth's upper atmosphere at a rate, averaged over the earth's surface, of $0.15 \text{ protons/cm}^2\text{-sec}$. What total current does the earth receive from beyond its atmosphere in the form of incident cosmic ray protons? (Earth's radius= $6.4 \times 10^6 \text{ m}$). 8

2. a) What is an electric dipole? Draw the electric field lines (E) and the equipotential lines for an electric dipole. 7
- b) An electric dipole is placed in an electric field E . Show that the potential energy of the dipole is given by $U = - p \cdot E$ where the symbols have their usual meaning. 10
- c) An electric dipole consists of two opposite charges of magnitude $q = 1.0 \times 10^{-6} \text{ coul}$. separated by $d = 2.0 \text{ cm}$. The dipole is placed in an external field of $1.0 \times 10^5 \text{ Nt/coul}$.
 - i. Calculate the maximum torque exerted by the field on the dipole
 - ii. How much work must an external agent do to turn the dipole end for end from a position $\theta = 180^\circ$ to $\theta = 0^\circ$?

3. a) Discuss the wave and particle properties of light. Distinguish Einstein's photoelectric effect and Compton effect. 7
- b) Describe with a clear circuit diagram the phenomenon of Einstein's Photo-electric effect. How would you evaluate the value of Planck's constant 'h' from this experiment? Draw stopping potential (V_s) versus frequency (f) curves for 3 light filters having wavelengths $\lambda = 430, 530, \text{ and } 695 \text{ nm}$. 10
- c) A 100 Watt sodium vapor lamp is placed at the center of a large sphere which absorbs all the sodium light that falls on it. At what rate are photons delivered to the sphere? (The wavelength of sodium light is 590 nm) 8

4. a) Discuss Einsteins general theory of relativity. What do you mean by the term "curvature of space"? What is a gravitational lens? Describe how light from a distant Quaser bend near a massive star. 7
- b) Derive Lorentz Transformation equations. Also write down the inverse transformation equations. Briefly discuss how a single event in one frame of reference may appear as two events from a different frame. 10
- c) A rod lies parallel to the x-axis of reference frame S, moving along this axis at a speed $0.630c$. The rods rest length is 1.70 m. What will the length of the rod be as measured from the S frame? 8

5. a) Discuss the phenomenon of interference of light. What are constructive and destructive interference? Give examples of each. 7
- b) In Young's double slit experiment , a monochromatic light illuminating the double slit produces interference fringes on the screen placed at a distance D from the slits. Assuming slit width $d \ll D$, derive expressions for the maximum and minimum intensity. 10
- c) The double-slit arrangement as in question b is illuminated with light from a mercury vapor lamp so filtered that only the strong green line ($\lambda = 5460 \text{ A}$) is effective. The slits are 0.10 mm apart, and the screen is 20 cm away from the slits. Calculate the angular positions of the first minimum and of the 10th maximum. 8
6. a) Discuss polarization of light. Describe how an un-polarized light can be plane-polarized using a polarizing sheet. How did Malus discover the phenomenon of polarization? 7
- b) Derive Brewster's law of polarization of light. What are optically isotropic and anisotropic substances? How is this property being used in different engineering designs? Name some of the optically anisotropic substances. 10
- c) A quartz quarter-wave plate is to be used with sodium light ($\lambda = 5890 \text{ A}$). Calculate the thickness of the quartz glass slab (Quartz is a doubly refracting Crystal with $n_o = 1.544$, and $n_e = 1.553$). 8
7. a) Discuss electrical resistance and resistivity from the atomic point of view. Describe how electrical resistance change with temperature in metallic conductor and a super-conductor. 7
- b) What are Ohmic and non-Ohmic conductors? Derive an expression for the current density J in terms of drift velocity and hence obtain the expression for resistivity $\rho = m/e^2 n t$ where the symbols have their usual meaning 10
- c) A wire of length $L = 2.35 \text{ m}$ and diameter $d = 1.63 \text{ mm}$ carries a current I of 1.24 A. The wire dissipates electrical energy at the rate P of 48.5 mW. Calculate the resistivity of the wire. 8
8. a) Classify different types of magnetic materials. What are soft and hard magnetic materials? 7
- b) Draw the hysteresis loop of a ferromagnet. Name the important points on the loop and explain their significance. What are magnetic coercivity and retentivity? How do they help identify the magnetic soft and hardness of a magnetic material? 10
- c) What is a magnetic domain? How does a magnetic domain function in a memory device? Discuss the salient features of a magnetic storage device. 8

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

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2018-2019

DURATION: 3 Hours

FULL MARKS: 150

CSE 4173: Introduction to Database Management System

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

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

1. a) Describe some application where database system is widely used. 10
 b) Write down the relational schema for the following E-R diagram. 15

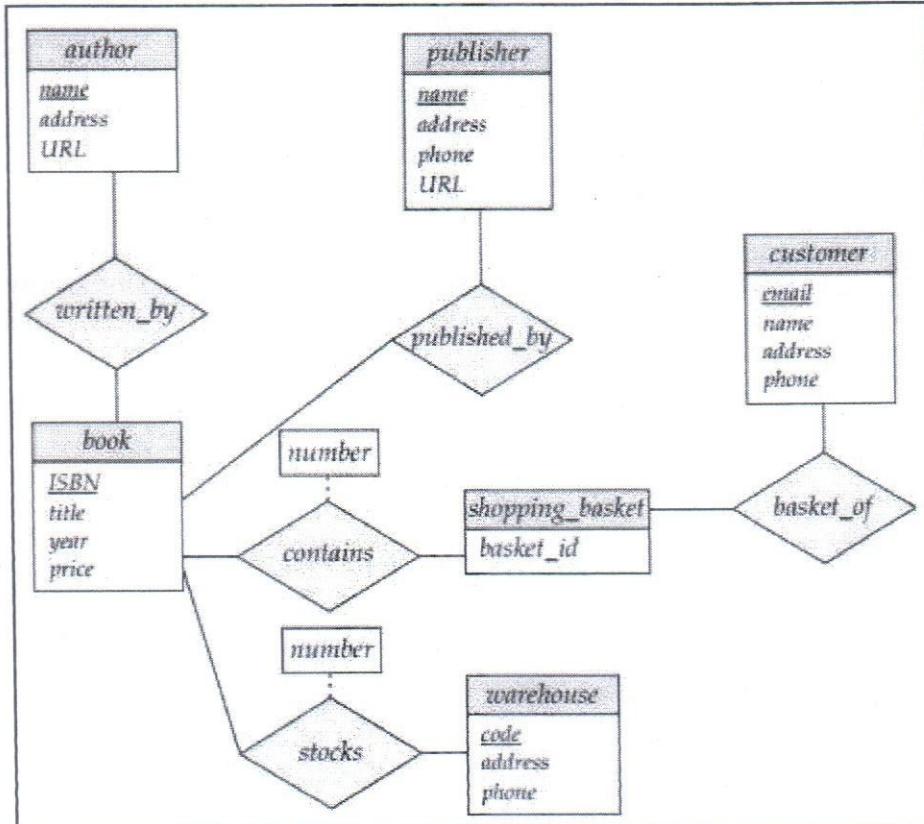


Figure1: E-R Diagram

2. a) Design a generalization-specialization hierarchy for a motor vehicle sales company. The company sells motorcycles, passenger cars, vans, and buses. Justify your placement of attributes at each level of the hierarchy. Explain why they should not be placed at a higher or lower level. 10
 b) Explain Database Architecture with necessary figure. 15
3. **employee** (person name, street, city)
works (person name, company name, salary)
company (company name, city)
branch (branch name, branch city, assets)
customer (customer name, customer street, customer city)
loan (loan number, branch name, amount)
borrower (customer name, loan number)
account (account number, branch name, balance)
depositor (customer name, account number)

- | | | |
|----|--|----|
| a) | Write down the appropriate primary key and foreign key of the above mentioned tables. | 10 |
| b) | Write down the following SQL <ul style="list-style-type: none"> i. Customers in board bazar branch with less than \$100. ii. Name of the street where the highest paid employee resides. iii. List of customers borrowing greater than \$500 from Board Bazar Branch. | 15 |
| | <i>classroom (building, room_number, capacity)</i> | |
| | <i>department (dept_name, building, budget)</i> | |
| | <i>course (course_id, title, dept_name, credits)</i> | |
| | <i>instructor (ID, name, dept_name, salary)</i> | |
| | <i>section (course_id, sec_id, semester, year, building, room_number, time_slot_id)</i> | |
| | <i>teaches (ID, course_id, sec_id, semester, year)</i> | |
| | <i>student (ID, name, dept_name, tot_cred)</i> | |
| | <i>takes (ID, course_id, sec_id, semester, year, grade)</i> | |
| | <i>advisor (s_ID, i_ID)</i> | |
| | <i>time_slot (time_slot_id, day, start_time, end_time)</i> | |
| | <i>prereq (course_id, prereq_id)</i> | |
| a) | Write down the E-R diagram for the above schema. | 15 |
| b) | What is mapping cardinality in E-R diagram? Describe the mapping cardinalities with appropriate figure. | 10 |
| a) | How to express the natural join using other relational algebra? Explain with example. | 10 |
| b) | SQL language has several parts. Explain the several parts of SQL mention below with necessary example. <ul style="list-style-type: none"> i. DDL ii. DML iii. Integrity iv. Transaction Control | 8 |
| c) | What is the difference between super key, primary key and candidate key? | 7 |
| a) | Write short notes on: <ul style="list-style-type: none"> i. Normalization ii. View iii. Strong Entity Set iv. Specialization and Generalization v. Weak Entity Set | 25 |
| a) | A direct design process is difficult for real-world applications, since they are often highly complex. Explain different phases of database design process. | 12 |
| b) | In designing a database schema, we must ensure that we avoid two major pitfalls. What are those? Explain its necessity. | 8 |
| c) | What is entity set and relationship set? | 5 |
| a) | What do you mean by functional dependency? Explain with example. What are trivial functional dependency and closure of a set of functional dependencies? | 10 |
| b) | What is meant by normalization?
Consider the relational schema R(A, B, C, D, E, F, G) with following functional dependencies:
$C \rightarrow F$
$F \rightarrow E$
$A \rightarrow GB$
$FE \rightarrow DA$ | 10 |
| | Decompose R into BCNF. Show all the steps. | |
| c) | Explain the Armstrong's axioms. List the additional rules to compute F^+ | 5 |

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Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2018-2019

DURATION: 3 Hours

FULL MARKS: 150

CSE 4175: Computer Programming

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

There are 8 (eight) questions. Answer any 6 (six) of them.

Figures in the right margin indicate marks.

- | | |
|--|-----|
| 1. a) What is a string? Write code to mimic the functionalities of the STRCAT string function. | 1+7 |
| b) Write necessary code to take a string as input and print it in reverse order. | 7 |
| c) Write necessary code to count the number of words in a string and make initial letter of each word in capital letter and rest in small letter. | 10 |
| 2. a) What are ASCII Values and ASCII Characters? Write a program to print the ASCII values of character starting from '0' up to '9'. | 2+8 |
| b) Write down code to print all prime numbers within the range of 0 to 100. | 15 |
| 3. a) Write a C program which will take input from a file in a character by character manner until end of file and append the input of that file into a new file. For the purpose of coding you can choose any filename that you like. | 15 |
| b) Write a code to take 10000 integers as input and print their average and sum. | 10 |
| 4. a) What is pointer and why it is not used in modern languages? | 1+2 |
| b) Create a user defined function which can swap two values by reference and use it to swap value from the main function. | 12 |
| c) Write down the difference between gets() and scanf() in case of taking a string as input. Explain with suitable examples. | 6 |
| d) What is recursion? Can recursive function do the work of a loop? | 4 |
| 5. a) Write down the output for the following code | 7 |

```
#include<stdio.h>

int rec_sum(int x){
    if(x!=1) return x+rec_sum(x-1);
}

void s(int a, int b){
    printf("%d %d\n",a,b);
    a = a + b;
    b = a - b;
    a = a - b;
    printf("%d %d\n",a,b);
}

int main(void){
    int m=3,n;
    n=rec_sum(m);
    printf("%d\n",n);
    s(m,n);
    printf("%d %d\n",m++,++n);
    return 0;
}
```

- b) Describe calling a function by value and reference. Give suitable examples for explanation. 8
- c) Write a C program which can check whether an input string is palindrome or not. 10
6. a) Describe three different loop structure in C with examples. 9
- b) Can we use break to stop the loop of recursive function? If no, then explain how we stop the recurrence of a recursive function. 9
- c) Write a program which will take 1000 integers as input and sort them in ascending order. 7
7. a) Write a program which will take an integer n as input and print from 1 up to n in the following way: 10
- 1
2 3
4 5 6
7 8 9 10
11 12
- The output above is given for n = 12
- b) The semester final in IUT is almost at an end and so the IUTians are eagerly planning a tour but they are in a dilemma whether to go. Some of the constraints are money and how well did they perform in the exam. If someone has performed **very good** in the exam no matter how much money s/he has, s/he will visit **Cox's Bazar** even by borrowing money from her/his friends. But if someone has performed **good** and has at least **5000** BDT s/he will visit **Cox's Bazar**. Otherwise, if someone who performed **good** but has **less than 5000**, will visit places in **Dhaka**. Finally, if someone performed **bad**, then no matter how much money s/he has, s/he will **Stay Home** and prepare her/himself to ace the next semester.
 Now, you have to write a program where it will take and an integer & a string as input and based on the scenario described above print whether the student will visit Cox's Bazar/ Dhaka / Stay Home.
- c) Write a program which will take three integers as input print the maximum and minimum value among those three values. 5
8. a) Write a code to print Fibonacci numbers within the range of 0 to 10000. 13
 i.e. : 0 1 1 2 3 5 8 13
- b) Write code using recursion function to print from 1000 to 1. (decreasing order) 12

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Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2018-2019

DURATION: 3 Hours

FULL MARKS: 150

CSE 4301: Object Oriented Programming

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

There are 8 (eight) questions. Answer any 6 (six) of them.

Figures in the right margin indicate marks.

1. a) Create a class called SampleClass with a private integer x. The parameterized constructor of the class initializes the value of x. Write a program where you can create only one instance of class SampleClass. Create one function that changes the value of x. Another function should print the changed value of x. 6
- b) Using the keyword *new*, dynamically allocate memory for a certain number of objects of SampleClass from question 1(a). The number of objects should be defined by users. Use the same functions from question 1(a) to change and print the value of x for each of the dynamically created objects. Free the memory before the program terminates. 7
- c) Consider the following code snippet. 4x3

```
class BaseClass
{
    int x;
    protected: int y;
    public: int z;
};
class Derived_L1{};
class Derived_L2:Derived_L1{};
class StandAlone{};
```

Figure 1: Code for question 1(c)

Now consider the following scenarios and modify the code to implement them:

- i. Derived_L1 class inherits BaseClass in such a way that int y and int z can both be accessed by Derived_L2 class. However StandAlone class only can access int z.
- ii. Derived_L1 class inherits BaseClass in such a way that int y and int z can both be accessed by Derived_L2 class. But StandAlone class none of the integers.
- iii. Derived_L1 class inherits BaseClass in such a way that int y and int z can be accessed neither by Derived_L2 class nor by StandAlone class.

Is there any way for any of the classes -Derived_L1, Derived_L2 or StandAlone to access int x of BaseClass. Explain your answer.

2. Consider the following tables:

25

Table 1: Sample Product for question 2(a)

Product ID	Product Name	Product Price
AF0012	iMab 21"	150.000
AF0014	iPhines 6s	68.000
AF0016	Samtung S6 Edge	79.000
AF0018	NyVidia 750M	10.000

Table 2: Sample Order for question 2(a)

Order ID	Order Details	Order Date
CB0012	Lots of phones	21/1/2016
CB0014	Lots of PCs	21/5/2016
CB0016	Many GFXs	21/9/2016
CB0018	Everything	22/1/2016

Table 3: Sample Invoice for question 2(a)

Invoice ID	Order ID	Product ID	Quantity
EF0012	CB0012	AF0014	4
EF0014	CB0012	AF0016	8
EF0016	CB0014	AF0012	10
EF0018	CB0016	AF0018	9
EF001A	CB0018	AF0012	7
EF001C	CB0018	AF0014	6
EF001E	CB0018	AF0016	23
EF0021	CB0018	AF0018	12

Now write a program that will have three different classes called **Product**, **Order** and **Invoice**. These classes will have properties as pointed by the tables. In **Invoice** class, there should be a **pointer** to the **Product** and **Order** class. Create a separate class called **Service**, which will have a method that takes an **Invoice** type object and calculate total amount due for each **Order**.

Hint: Use copy constructor where necessary.

3. a) Consider the following code snippet of a program. The program is incomplete. You have to complete the program according to the instructions given in the code as comment. 20

```
class Product
{
    int ID;
    float product_price;
    char *product_name;
public:
    Product(){}
    /*Take input from the users to set values of the properties*/
}
Product(int ID, float product_price, char *product_name){
    //Assign values from the parameters to the properties
}
Product compare_product_price(Product p1){
    //Compare the price of the current Product with Product P1
    //Return the Product with higher price
    //If two products have the same price, return the current
Product
}
~Product() {/*Release the memory allocated for 'product_name' */}
```

```

*****  

    Write your own code here to stop this class generating any error  

    when any memory is released  

*****  

*/  

};  

class Order  

{  

    int order_ID;  

    Product *product_list;  

    int dd, mm, yyyy;  

public:  

    Order(){  

        //Set order_ID by taking input from user  

        //Create an order with 10 products.  

        //Put the products inside 'product_list'  

    }  

    /*****  

***  

    The following method should generate TWO memory allocation  

errors.  

    What are they?  

    Write your own code to solve those problems.  

    [Do not make any changes inside the method 'set_order']  

*****  

*/  

    void set_order(Order passed_order){*this = passed_order;}  

    ~Order()/*Erelease any memory allocated for 'product_list'*/}  

}

```

Figure 2: Code for question 3(a)

- b) What would be the output of the following program:

```

int x=5;
int foo(){
    x = 30;
    return x;
}
int main(){
    x = foo() + 3;
    cout << x << endl;
    return 0;
}

```

5

Figure 3: Code for question 3(b)

4. a) A book shop maintains the inventory of books to be sold at the shop. Shopkeeper of the book-shop can generate a list having details (e.g. author, title, price and stock position) of different books available there. The number of different books in the book-shop and number of copies for each book are variables. The shopkeeper may also look for a particular book that has been sold highest number of copies yet.

20

Whenever a customer wants a book, the sales person inputs the title, author and number of copies required. The system then searches and displays whether it is available or not. In case of availability of the requested book, the total cost of the requested copy is displayed. Otherwise the message "Required copies not in stock" is displayed.

Design this system using necessary classes with suitable member functions and variables. However every member variables must be declared under private access modifier and class definition should include suitable constructor(s). Use of *new* operator is recommended in necessity of dynamic memory allocation. Write the complete C++ program which suites above requirements.

- b) What are the main purposes of having constructors and destructor in a class?

5

5. a) What would be the output of the following code:

10

```
class TestClass
{
    int x;
public:
    TestClass(int x){this->x = x;}
    ~TestClass(){cout << "Destroying: " << x << endl<<endl;}
    void set_x(TestClass t){
        cout << endl << endl << "Inside set_x:\n";
        cout << "t.x: " << t.x << endl;
        cout << "this->x: " << this->x << endl << endl;
        *this = t;
        t.x += 2;
    }
    void print_x(){cout << "Print_x: " << x << endl;}
    TestClass(const TestClass &t){
        cout << "Inside Copy Constructor:\nBefore Assignning: t.x= "
            << t.x << "; this->x= "<<this->x << endl;
        this->x = t.x + 10;
        cout << "After Assignning: t.x= "
            << t.x << "; this->x= " << this->x << endl;
    }
};
int main(){
    TestClass t1(1), t2(2);
    t2.set_x(t1);
    t1.print_x();
    t2.print_x();
    cout << endl;
    return 0;
}
```

Figure 4: Code for question 5(a)

- b) The **Interface** files given below shows the structures of two classes: **Revenue** and **CustomDateTime**. They are incomplete and to complete them you can find instructions given in the comments. You have to create separate **Implementation** files and add appropriate header files.

15

```

class Revenue {
    string name, address, organization;
long revenue_id;
int insurance_no, age;
public:
/*** * Initialize the properties of 'Revenue' in the default constructor
with the following values:
* name="Sauron"; address="Mordor"; organization="Middle Earth"
* revenue_id=104435; insurance_no=1207; age=20 ***
Revenue();
/*** * Overloaded constructor to take in all the properties as
parameters and initializing them as list of initializers
* DO NOT send the age to the constructor directly.
* Rather send the BirthDate of the user as CustomDateTime object and
calculate Age by using method in CustomDateTime Class.
* You may assume any date as TODAY ***
/*** * Create getters and setters for each of the variables ***
};

class CustomDateTime {
    /*** * Declare variables to create CustomDateTime Objects like the
following:
* dd-mm-yyyy hh:mim:ss ***
public:
    /*** * Parameterized constructors that take only the 'dd-mm-yyyy'
portion of the date ***
/*** * Parameterized constructors that take only the full formed
DateTime like this:
* 'dd-mm-yyyy hh:mim:ss' ***
/*** * Parameterized constructors that take only the full formed
DateTime like this: 'dd-mm-yyyy hh:mim:ss' ***
/*** * Calculate the age by subtracting dd-mm-yyyy from birthDate ***
int CalculateAge(CustomDateTime birthDate);
    /*** * Calculate the age by subtracting today from birthDate ***
int CalculateAge(CustomDateTime birthDate, CustomDateTime today);
};

```

Figure 5: Code for Question 5(b)

6. a) C++ supports inheritance and aggregation features to represent appropriate relationship between two classes. Mention at least two real world examples for each category to distinguish the implementation of these two features. 7
- b) Does the function prototypes illustrated at Figure-6 fulfill all the criteria for overloading the function *getMax*? Justify your answer. 5

```

int getMax( int x, float y );
float getMax( int a, float b );

```

Figure 6: Code segment for question 6(b)

- c) Create a class called “*distance*” with member variables named *feet* and *inches* and appropriate constructor(s). Overload the greater than operator (*>*) for the *distance* class to tackle the following conditions : 13
- D1 > D2*;
 - D1 > float*;

Where *D1* and *D2* are objects of the *distance* class and *float* is a floating point value representing distance (ex: 4.5 means 4 feet 6 inches).

7. a) Write a generic function called *min()*, that returns the lesser of its two arguments. For example, *min(3,4)* will return 3 and *min('c', 'a')* will return 'a'. Demonstrate your function in a program. 8
- b) How is *exception handling* done in C++? 5
- c) Can you write a *try-catch* block that will catch all type of exceptions? 3
- d) Define a class which can keep track of number of objects already created belonging own class. 9
8. a) Compare the concept of *function overloading* and *function overriding* with appropriate examples. 8
- b) What is a *pure virtual member function*? 4
- c) What happens when a derived class inherits a base class as *protected*? 3
- d) What is a *friend function* and why do we need it? 5
- e) The following program contains ambiguous statement(s). Remove the ambiguity with appropriate correction(s). 5

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

class base {
public:
    int i;
};

class derived1 : public base {
public:
    int j;
};

class derived2 : public base {
public:
    int k;
};

class derived3 : public derived1, public derived2 {
public:
    int product() { return i * j * k; }
};

int main()
{
    derived3 ob;
    ob.i = 10;
    ob.j = 3;
    ob.k = 5;
    cout << "Product is " << ob.product() << '\n';
    return 0;
}
```

Figure 7: Code for question 8(e)

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

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2018-2019

DURATION: 3 Hours

FULL MARKS: 150

SWE 4301: Object Oriented Concepts II

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

There are **8 (eight)** questions. Answer **6 (six)** of them including **Questions 1, 2 and 3**.

Figures in the right margin indicate marks.

A list of code and design smells is given at the end of the question paper as Appendix

1. [Mandatory]

- a) "Subclasses get to inherit the methods and data of their parents. But what if they don't want or need what they are given?" – Martin Fowler 3+3
- i. Which code smell is Martin Fowler referring to?
 - ii. Violation of which design principle is caused by this code smell ?

- b) You are developing the software for InsaBot, IUT Mars Rover's humanoid Robot. InsaBot 15+4 has a very flexible design. Part of its flexibility is that, different types of same body parts can be attached to it.

Hardware of two types of legs – *FootyLeg* and *WheelyLeg*, and two types of heads – *SquareHead* and *FlatHead* are already manufactured. More legs and heads are under construction. Also, the *WheelyLegs* have wheels that can be of different types. *Ballen*, *Linen* and *Penten* wheels are already out there. Few more types are coming soon. *FootyLeg* is again of two types – *RoundFootyLeg* and *FlatFootyLeg*.

As an initial design of the robot's software, do the followings –

- i. Draw a class diagram to design this scenario. Only mentioning the class names, composition and subtype relations is sufficient. Include an InsaBot class in your design.
- ii. Write body of the InsaBot class.

2. [Mandatory]

You requested your friend to review your code of InsaBot. Answer the following questions related to the comments your friend has made about the code.

- a) "These few classes are too coupled. You need to apply DIP properly so that coupling is reduced". Do you agree with your friend that coupling can be reduced by applying DIP? Defend your opinion. 6
- b) "There is a violation of LSP in this class. There might be violation of OCP somewhere as well". Explain why your friend suspects that OCP violation might also be there. 7
- c) "This class has too many fields and methods. I haven't gone through the details but I think there might be violation of SRP". Do you agree that a class having too many members is related to SRP violation? Justify your answer. 6
- d) "InsaBot currently has a childlike voice. But I think adult male and female voice might be required to be supported very soon. You should take measures immediately so that you can easily integrate different types of voice in the future". Will you take any measures now? 6
- If yes, what measures will you take?
 - If no, explain why you will not take any measure.

3. [Mandatory]

- a) InsaBot's hand has three operations – grab, release and punch. Therefore, you designed the interface InsaHand as shown in code Listing 1. Two classes that currently implement the interface, MagnatoHand and ClawHand, are also shown in the listing. The team soon realizes that they also need a simple version of hand, a Hammer Hand that can only punch. So you develop HammerHand class as shown in the listing.
- What quality issues (code smell, design smell or violation of a design principle) can you find in the code?
 - Redesign the code so that the quality issues are resolved.

```

interface InsaHand {
    void punch();
    void grab();
    void release();
}
class MagnatoHand implements InsaHand {
    // all three methods implemented
}
class ClawHand implements InsaHand {
    // all three methods implemented
}
class HammerHand implements InsaHand {
    @Override
    public void punch() {
        // implementation of punch goes here
    }
    @Override
    public void grab() {
        // cannot grab, no implementation
    }
    @Override
    public void release() {
        // cannot release, no implementation
    }
}

```

Listing 1: Code for Question 3 (a)

- b) Consider natural subtyping among the classes Mango, Fruit and Banana in listing 2. Now write 4 lines of code in the demo method as instructed below.

- Demonstrate *compilation error* by calling useMango. Use a type casting.
- Demonstrate *runtime error* by calling useFruitAsMango.
- Demonstrate *unnecessary cast* by calling any method. Use a type casting.
- Demonstrate *runs without any error* by calling any method.

```

class UseFruit {
    public static void useMango(Mango mango) {
        System.out.println(mango);
    }
    public static void useFruit(Fruit fruit) {
        System.out.println(fruit);
    }
    public static void useFruitAsMango(Fruit fruit) {
        Banana banana = (Banana) fruit;
        System.out.println(banana);
    }
    void demo(){
        Fruit fruit = new Fruit();
        Mango mango = new Mango();
        Banana banana = new Banana();
        // write code here
    }
}

```

Listing 2: Code snippet for Question 3 (b)

4. a) i. What is *dead code*? ii. What is the remedy of *dead code*? 3+2
 b) i. What code smells do you see in the code listing 3? 4+9
 ii. Rewrite the code so that code smells are removed.

```

class Course {
    String name;
    double credits;
}
class CourseHelper {
    void printCourses(int studentId, String name, Course[] courses) {
        System.out.println(studentId + ":" + name);
        for (Course course : courses) {
            System.out.println(course);
        }
    }
    void printCredits(int studentId, String name, Course[] courses) {
        double totalCredits = 0;
        for (Course course : courses) {
            totalCredits += course.credits;
        }
        System.out.println(studentId + ":" + name + ":" + totalCredits);
    }
}
  
```

Listing 3: Code for question 4 (d)

- c) Give a code example to demonstrate *feature envy*. 7
5. a) Write full names of five SOLID design principles. 5
 b) Draw two dependency graph of same program with 10 nodes. One before and another after DIP is applied. Show program flow direction and source code dependency direction between the nodes. 10
 c) Identify at least 10 objects from the paragraph below. For each of the objects, mention which type the object belong to. You may identify multiple objects of same type. 10
Note: The types of objects may or may not be mentioned in the paragraph. A single object can be represented by one or more words.

The Battle of Uhud was a battle between the early Muslims and the Qurayshis of Makkah. The battle took place near Mount Uhud, to the north of Medina. The Qurayshi army was led by Abu Sufian, Khalid Ibn Walid, 'Amr Ibn al-'As. Interestingly, all three of them later converted to Islam and played significant role in Muslim army. The Battle of Uhud resulted in a lot of loss to Muslims, including death of Hamza (R). The grave of Hamza (R) and many other Martyrs of Uhud are near the mountain.

6. a) "The project was not compiling because of that code smell. So we fixed it, however, now we are getting a runtime error for this design smell".— You told this and your project supervisor said this does not really make any sense. Why is your supervisor saying so? Explain in no more than 5 sentences. 5
 b) Give code examples of lazy class: 3+3
 i. Using composition ii. Using subtyping
 c) Two facts about code are – "code is read far more times than it is written" and "code will always require to change". State the implications of these two facts. 4
 d) The code in listing 4 below has comments because it has lack of abstraction. Refactor the code so that the comments are not required. You do not have to remove the conditionals. 10

```

class Tour {
    int totalDuration; // total tour time in days
    int journeyTime; // time in hour
    int distance; // distance from home

    public String getComment() {
        if (totalDuration < 1) { // Day out
            if (distance < 40) { // short journey
                return "no fun";
            } else if (distance >= 40 && journeyTime < 1) {
                // long journey, short time
                return "no comment";
            } else {
                return "tiring";
            }
        } else if (totalDuration < 2) { // short trip
            if (distance > 100) { // long journey
                return "tiring";
            } else {
                return "nice!";
            }
        } else { // long trip
            if (distance <= 100) { // medium journey
                return "not bad";
            } else { // long journey
                return "great!";
            }
        }
    }
}

```

Listing 4: Code for question 5 (d)

7. a) Give code example of the following two code smells: 3+3
 i. Conditional statement ii. Conditional complexity
- b) What is cohesion? Give a code example to demonstrate lack of cohesion. 3+5
- c) i. What is abstract class? 2
 ii. Can an abstract class have constructors? 2
 iii. If all methods of an abstract class are abstract, can we call it an interface? 3
 iv. Give a code example of abstract class. 4
8. a) i. What is refactoring? 3+6+3
 ii. Why is unit testing is essential for refactoring?
 iii. What is “baby step” in the context of refactoring?
- b) i. What is fragile design? 3+2
 ii. Violation of which design principle normally results in fragile design?
- c) Are encapsulation and information hiding same thing? Justify your answer in no more than 10 sentences. 8

Appendix

List of code/design smells: Black Sheep, Comments, Conditional Complexity, Conditional Statement, Data Clumps, Dead Code, Duplicated Code, Feature Envy, Fragility, Immobility, Inappropriate name, Large class, Lazy Class, Long method, Needless Complexity, Needless Repetition, Opacity, Primitive Obsession, Refused Bequest, Rigidity, Speculative Generality, Viscosity.

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

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2018-2019

DURATION: 3 Hours

FULL MARKS: 150

CSE 4303: Data Structures

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

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

1. a) Define Data Structure. Translate Q into its equivalent postfix expression P using stack. 9

$$Q = ((A + B) / (C + D)) \uparrow (E / F) + (G + H) / I$$
 - b) For each of the following situations, name the best sorting algorithm: 8
 - i. You need an $O(n \log n)$ sort even in any case and you cannot use any extra space except for a few local variables.
 - ii. You have many compound data sets to sort separately and each one has around 100 elements.
 - iii. Instead of sorting the entire data set, you only need the k smallest elements where k is an input to the algorithm but is likely to be much smaller than the size of the entire data.
 - iv. The marks (out of 300) of CSE 4303 course for 1 million students is stored randomly in a file. Now, you are given a simple task of sorting all the marks in descending order.
 - c) You are given a sorted array A of size 200000 elements. Five values are appended at the end of the array. Which sorting algorithm would be a better candidate for sorting the whole array? Write down the working procedure of that sorting algorithm. 8
-
2. a) Given a graph $G = (V, E)$ with positive edge weights. Now apply the Bellman-Ford algorithm and Dijkstra's algorithm. Can they produce different shortest-path trees despite always producing the same shortest-path weights? Justify your answer. 6
 - b) Consider the undirected, weighted graph given in Figure 1. Step through Dijkstra's algorithm to calculate the single-source shortest paths from A to every other vertex. Show your steps by using a single table. Also list the vertices in the order which you marked them visited. Finally, indicate the lowest-cost path from node A to node F. 12

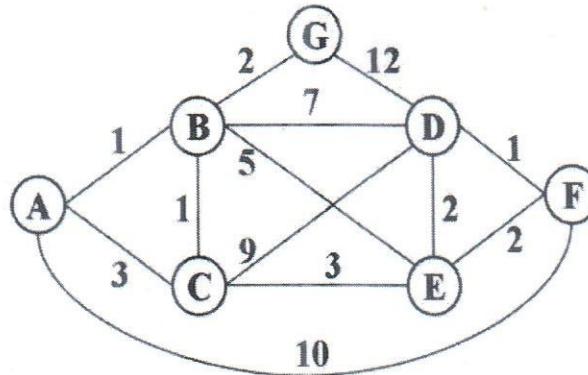


Figure 1: Graph for question no. 2 (b)

- c) Define Big-Omega. Let the numbers 794, 332, 561, 342, 200, 607 and 893 be sorted using radix sort. What will be the 6th number in the sequence of numbers after sorting the 2nd digit? 7
3. a) Insert the following 15 randomly generated objects into a binary search tree in the order they are listed. 12
 34, 15, 65, 62, 69, 42, 40, 80, 50, 59, 23, 46, 57, 3, 29

- i. Give two integers that could be inserted into this tree that would increase the height of this tree
- ii. From the initial tree remove the root node three times by copying up the smallest element of the right sub-tree
- iii. Use the binary search tree you created in (ii). Point out the nodes where the property of AVL tree has been violated
- b) Write down two major purposes of STL *set* operation. Give one example with a practical application. 5
- c) Draw the following graphs: 8
- K_5
 - $K_{5,3}$
 - W_5
 - Among these three graphs which is/are Euler?
4. a) Mention some properties of a good hash function. Consider an initially empty hash table of size M and hash function $h(x) = x \bmod M$. In the worst case what is the time complexity (in Big-Oh notation) to insert n keys into the table if separate chaining is used to resolve collisions? Firstly, write down the answer by considering an unordered linked list where an element is inserted at the beginning of the list. Secondly, write down the answer by considering an ordered linked list. 4+4
- b) Define perfect binary tree. Proof that a perfect binary tree of height h has $2^{h+1} - 1$ nodes. 7
- c) Define Load factor in hashing. Consider a hash table of size 13 storing entries with integer keys. Suppose the hash function is $h(k) = k \bmod 13$. Insert, in the given order, entries with keys **27, 40, 30, 56, 53, 118, 121, 131, 134** into the hash table to resolve collisions using:
- Separate Chaining
 - Linear-Probing with $h_i(k) \Rightarrow (h(k) + f(i)) \bmod 13$, where $f(i) = i$
 - Quadratic-Probing with $h_i(k) \Rightarrow (h(k) + f(i)) \bmod 13$, where $f(i) = i^2$
 - Double-Hashing with h as the hash function and h_2 as the second hash function
 $h_i(k) \Rightarrow (h(k) + ih_2(k)) \bmod 13$, where $h_2(k) = 7 - (k \bmod 7)$
5. a) Analyze the following code of Figure 2 and find out the complexity in terms of Big-O notation step by step. (try to make the upper bound tighter) 7
- ```
void complexity() {
 for (int i = 0; i < n + 100; ++i) {
 for (int j = 0; j < i * n; ++j) {
 sum = sum + j;
 }
 for (int k = 0; k < n + n + n; ++k) {
 c[k] = c[k] + sum;
 }
 }
}
```
- Figure 2: Code segment for question no. 5 (a)
- b) The frequencies of characters used in an arbitrary message are as follows: 10  
**A : 5, B : 2, C : 8, D : 7, E : 3, F : 7, G : 1**  
Show the complete Huffman tree for these characters and represent the values in binary for node C, A, E and G of the Huffman tree using Huffman coding. (In Huffman tree, every left branch is coded with 0 and every right branch is coded with 1).
- c) Write down the pseudo code of Bellman Ford algorithm and analyze the complexity of this algorithm. 8
6. a) Define DAG with appropriate figure. What is the maximum number of edges  $m$  that can exist in a simple DAG with  $n$  vertices? 8

- b) Discuss how you can increase the size of Queue when it is full, without changing the proper order of the elements of that Queue. Use figure if necessary. 6
- c) Perform topological sort on the graph given in Figure 3 and write down the sorted list of nodes. If there is more than one valid topological sort order, write down all of them. 11

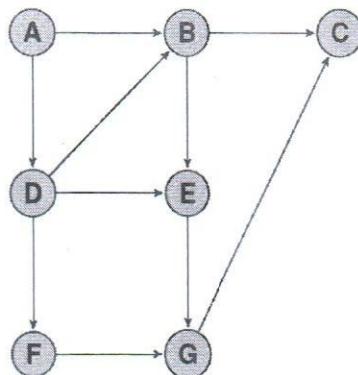


Figure 3: Graph for question no. 6 (c)

- i. List the nodes in the order they would be visited in a depth-first search and breadth-first search of the graph starting at A. When choosing a node to explore next, break ties in favor of the alphabetically least.
- ii. Determine all strongly connected components for the graph given in Figure 3.
7. a) Construct the binary tree for the following sequence of nodes in preorder and inorder respectively. 12

Preorder : G, B, Q, A, C, K, F, P, D, E, R, H

Inorder : Q, B, K, C, F, A, G, P, E, D, H, R

- b) Explain critical path for a directed graph with a suitable example. Find out the critical path and critical time for each of the node/task given in Figure 4. 13

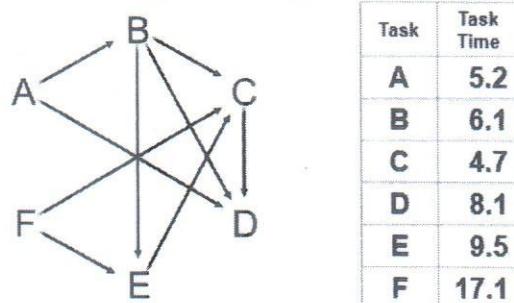


Figure 4: Graph for question no. 7 (b)

8. a) Give a Big-O bound on the *worst case* running time for each of the following in terms of  $n$ : 10
- insert in an *AVL tree* of size  $n$
  - deleteMin* in a *binary min heap* of size  $n$
  - performing *quick sort* when all data are sorted in ascending order
  - height of an *AVL tree* of size  $n$
  - height of a *complete tree* of size  $n$
- b) Use Prim's algorithm starting at node A to compute the Minimum Spanning Tree (MST) of the graph given in Figure 5. Answer the followings: 5+4
- Write down the edges of the MST in the order in which Prim's algorithm adds them to the MST. Use the format (node 1; node 2) to denote an edge.
  - Write down the edges in the order in which Kruskal's algorithm adds them to the MST.

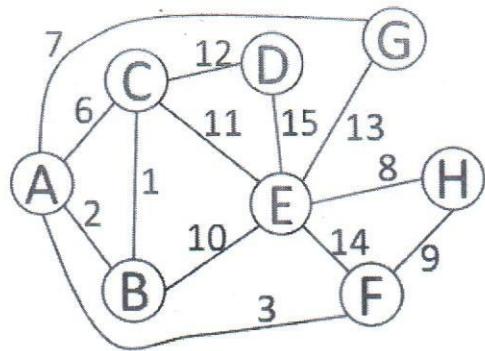


Figure 5: Graph for question no. 8 (b)

- c) Analyze the complexity of a singly linked list for *find*, *insert*, and *erase* operation by 6 considering the following positions.
- Front / 1<sup>st</sup>
  - Arbitrary location
  - Back / n<sup>th</sup>

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**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**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.**

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

- |    |                                                                                                                                                                                                                                                                                                                                   |    |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 1. | a) Write down the basic differences between the followings with suitable examples:                                                                                                                                                                                                                                                | 6  |
|    | i. Computer organization and computer architecture                                                                                                                                                                                                                                                                                |    |
|    | ii. Computer structure and computer function                                                                                                                                                                                                                                                                                      |    |
| b) | On the IAS, appositely describe the process that the CPU must undertake stepwise to read a value from memory and to write a value to memory in terms of what is put into the MAR, MBR, address bus, data bus, and control bus with necessary figures.                                                                             | 10 |
| c) | A pipelined processor has a clock rate of 2.5 GHz and executes a program with 1.5 million instructions. The pipeline has five stages, and instructions are issued at a rate of one per clock cycle. Ignore penalties due to branch instructions and out-of-sequence executions.                                                   | 9  |
|    | i. What is the speedup of this processor for this program compared to a non-pipelined processor?                                                                                                                                                                                                                                  |    |
|    | ii. What is throughput (in MIPS) of the pipelined processor?                                                                                                                                                                                                                                                                      |    |
| 2. | a) The instruction execution may involve several operations and depends on the nature of the instruction. Draw an instruction cycle state diagram with the interrupts which is required to comply in program execution cycle. Briefly describe all the states with a suitable example.                                            | 10 |
| b) | What happens when a check bit rather than a data bit is in error? How many check bits are needed if the Hamming error correction code is used to detect single bit errors in a 1024-bit data word? Justify your answer.                                                                                                           | 7  |
| c) | Consider a computer system that contains an I/O module controlling a simple keyboard/printer teletype (an electromechanical device that can be used to send and receive typed messages through various communications channels). The following registers are contained in the processor and connected directly to the system bus: | 8  |

INPR: Input Register, 8 bits  
 OUTR: Output Register, 8 bits  
 FGI: Input Flag, 1 bit  
 FGO: Output Flag, 1 bit  
 IEN: Interrupt Enable, 1 bit

Keystroke input from the teletype and printer output to the teletype are controlled by the I/O module. The teletype is able to encode an alphanumeric symbol to an 8-bit word and decode an 8-bit word into an alphanumeric symbol. Now answer the following questions:

- |     |                                                                                                                       |   |
|-----|-----------------------------------------------------------------------------------------------------------------------|---|
| i.  | Describe how the processor, using the first four registers listed in this problem, can achieve I/O with the teletype. |   |
| ii. | Describe how the function can be performed more efficiently by also employing IEN.                                    |   |
| 3.  | a) Define logical cache and physical cache. Comparatively distinguish them with necessary figures.                    | 8 |

- b) Suppose that the processor has access to two levels of memory. Level 1 contains 1000 words and has an access time of  $0.01 \mu s$ ; level 2 contains 100,000 words and has an access time of  $0.1 \mu s$ . Assume that if a word to be accessed is in level 1, then the processor accesses it directly. If it is in level 2, then the word is first transferred to level 1 and then accessed by the processor. For simplicity, we ignore the time required for the processor to determine whether the word is in level 1 or level 2. If 95% of the memory accesses are found in level 1, what is the average time to access a word? 5
- c) Consider a machine with a byte addressable main memory of  $2^{16}$  bytes and block size of 8 bytes. Assume that a direct mapped cache consisting of 32 lines is used with this machine. 12
  - i. How is a 16-bit memory address divided into tag, line number, and byte number?
  - ii. Into what line would bytes with each of the following addresses be stored?
    - 0001 0001 0001 1011
    - 1100 0011 0011 0100
    - 1101 0000 0001 1101
    - 1010 1010 1010 1010
  - iii. Suppose the byte with address 0001 1010 0001 1010 is stored in the cache. What are the addresses of the other bytes stored along with it?
  - iv. How many total bytes of memory can be stored in the cache?
  - v. Why the tag is also stored in the cache?
4. a) Magnetic disk is the foundation of external memory on virtually all computer systems. Briefly describe how data are recorded on and later retrieved from the disk with necessary figures. 8
- b) Write short notes on following terms: 5
  - i. Data striping
  - ii. RAID 10
  - iii. CD-R
  - iv. MZR
  - v. Pit
- c) Consider a single-platter disk with the following parameters: rotation speed: 7200 rpm; number of tracks on one side of platter: 30,000; number of sectors per track: 600; seek time: one ms for every hundred tracks traversed. Let the disk receive a request to access a random sector on a random track and assume the disk head starts at track 0. 12
  - i. What is the average seek time?
  - ii. What is the average rotational latency?
  - iii. What is the transfer time for a sector?
  - iv. What is the total average time to satisfy a request?
5. a) The processor needs to save information stored in several registers in system stack to resume the current program at the point of interrupt. When interrupt processing is complete, the saved register values are retrieved from the stack and restored to the registers. Now draw several figures to explain the above mentioned scenario with a portion of main memory and different registers of processor. 7
- b) To implement interrupt driven I/O, respective design issues are raised. Mention those design issues and also briefly describe different techniques to solve them. 10
- c) What is I/O channel? How many different types of I/O channels are there? Describe them with respective figures. 8
6. a) Many instruction sets contain the instruction NOOP, meaning no operation, which has no effect on the processor state other than incrementing the program counter. Suggest some uses of this instruction. 5
- b) Compare one-, two-, and three- address machines by writing programs to compute the following expression for each of the three machines. 12
 
$$X = (A + B * C) / (D - E * F)$$

- c) For the following data structure (figure 1), draw the big-endian and little-endian layouts, using the values given as comment:

```
struct {
 short i; //0x1112
 short j; //0x1314
 short k; //0x1516
 short l; //0x1718
} s3;
```

Figure 1: A data structure

7. a) An instruction format defines the layout of the bits of an instruction. The design of an instruction format is a complex art, and an amazing variety of designs have been implemented. There are several design issues in this context. Briefly describe those issues mentioning different trade-offs. 8
- b) A sharp contrast to the instruction set of the PDP-8 is that of the PDP-10 which was designed to be a large-scale time-shared system, with an emphasis on making the system easy to program. Briefly describe different design principles employed in designing the instruction set of PDP-10. 5
- c) Given the following memory values and a one- address machine with an accumulator, what values do the following instructions load into the accumulator? 12
- Word 20 contains 40.
  - Word 30 contains 50.
  - Word 40 contains 60.
  - Word 50 contains 70.
- i. LOAD IMMEDIATE 20
  - ii. LOAD DIRECT 20
  - iii. LOAD INDIRECT 20
  - iv. LOAD IMMEDIATE 30
  - v. LOAD DIRECT 30
  - vi. LOAD INDIRECT 30
8. a) With the earliest computers, the programmer interacted directly with the computer hardware without OS. These early systems presented two main problems. Briefly describe those problems with necessary examples. 5
- b) Comparatively describe partitioning, paging and segmentation in memory management. Among them, segmentation has a number of advantages to the programmer over a non-segmented address space. Briefly remarks on those advantages. 10
- c) List and briefly explain various ways in which an instruction pipeline can deal with conditional branch instructions. 10

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**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4305: Computer Organization and Architecture**

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There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

1. a) How many different types can the Datapath elements be broadly classified into? Name and describe each with an example. 8  
 b) Answer the following questions from the Table 1 below : 3x3

Table 1: for question 1.b)

| <b>IF</b> | <b>ID</b> | <b>EX</b> | <b>MEM</b> | <b>WB</b> |
|-----------|-----------|-----------|------------|-----------|
| 250ps     | 350ps     | 150ps     | 300ps      | 200ps     |

- i. What is the clock cycle time in a pipelined and non-pipelined processor?
  - ii. What is the total latency of an LW instruction in a pipelined and non-pipelined processor?
  - iii. If we split one stage of the pipelined Datapath into two new stages, each with half the latency of the original stage, which stage would you split and what is the new clock cycle time of the processor?
- c) The remaining problems in this question assume that instructions executed by the processor are broken down as follows in Table 2:

Table 2: for question 1.c)

| <b>ALU</b> | <b>BEQ</b> | <b>LW</b> | <b>SW</b> |
|------------|------------|-----------|-----------|
| 55%        | 15%        | 15%       | 15%       |

- i. Assuming there are no stalls or hazards, what is the utilization of the data memory? 2
  - ii. Assuming there are no stalls or hazards, what is the utilization of the write-register port of the "Registers" unit? 3
  - iii. Assuming there are no stalls and that 60% of all conditional branches are taken, in what percentage of clock cycles does the branch adder in the EX stage generate a value that is actually used? 3
2. a) What are the different types of hazard in pipelining? Describe each with appropriate examples. 10  
 b) As this instruction executes, what is kept in each register located between two pipeline stages? 9

SW R16, -100 (R6)

- c) If there is no forwarding or hazard detection, draw a multi clock cycle diagram and insert NOPs to ensure correct execution. 6

ADD R5, R2, R1  
 LW R3, 4 (R5)  
 LW R2, 0 (R2)  
 OR R3, R5, R3  
 SW R3, 0 (R5)

3. a) Suppose you want to perform two sums: one is a sum of 20 scalar variables and one is a matrix sum of a pair of two-dimensional arrays, with dimensions 20 by 20.  
 i. What speed-up do you get with 10 versus 100 processors?  
 ii. What speed up do you get with 10 versus 100 processors given the matrix grow to be 1000 by 1000? 10
- b) Why is it difficult to write parallel processing programs that are fast, especially as the number of processors increases? 5
- c) How does Shared Memory Multiprocessors (SMP) differ from Clusters? Explain with appropriate diagrams. 10
4. a) Explain briefly the I/O interfacing strategies of Polling, Interrupt Driven I/O and Direct memory access (DMA) including the problems of each strategy. 10
- b) A storage resource having a Mean Time to Failure (MTTF) of 7 years and a Mean Time to Replacement (MTTR) of 3 days is considered. Answer the following set of questions: 4x2
- i. Calculate the Mean Time Before Failure (MTBF) for the device.
  - ii. Calculate the availability for the device.
  - iii. What happens to availability as MTTR approaches 0? Is this a realistic situation?
  - iv. What happens to availability as MTTR gets very high i.e. a device is difficult to repair? Does this imply the device has low availability?
- c) Calculate the average time needed to read and write a 1024-byte sector from a disk having average seek time of 10 ms, RPM of 7500, disk transfer rate of 90 MB/s and controller transfer rate of 100 MB/s. Clearly state the formula. 7
5. a) What are the different types of Locality that determine memory access? 5
- b) How does "Write through" scheme differ from "Write back" scheme? Briefly describe each. 8
- c) Assuming a cache of 4K blocks, a 4-word block size and a 32-bit address, find the total number of sets and total number of tag bits for each of the following cache setups: 4x3
- i. Direct mapped
  - ii. Two way set associative
  - iii. Four way set associative
  - iv. Fully associative
6. a) Name the five classic components of a computer. What are the different levels of a program code and which components of a system are responsible for their conversion? 10
- b) State Amdahl's Law mentioning the formula and appropriate example. 5
- c) There are four classes of instructions, A, B, C, and D. The clock rate and CPI of each implementation is given in Table 3. 4+3+3

Table 3: for question 6. c)

|    | Clock Rate | CPI Class A | CPI Class B | CPI Class C | CPI Class D |
|----|------------|-------------|-------------|-------------|-------------|
| P1 | 2.5 GHz    | 1           | 2           | 3           | 3           |
| P2 | 3 Ghz      | 2           | 2           | 2           | 2           |

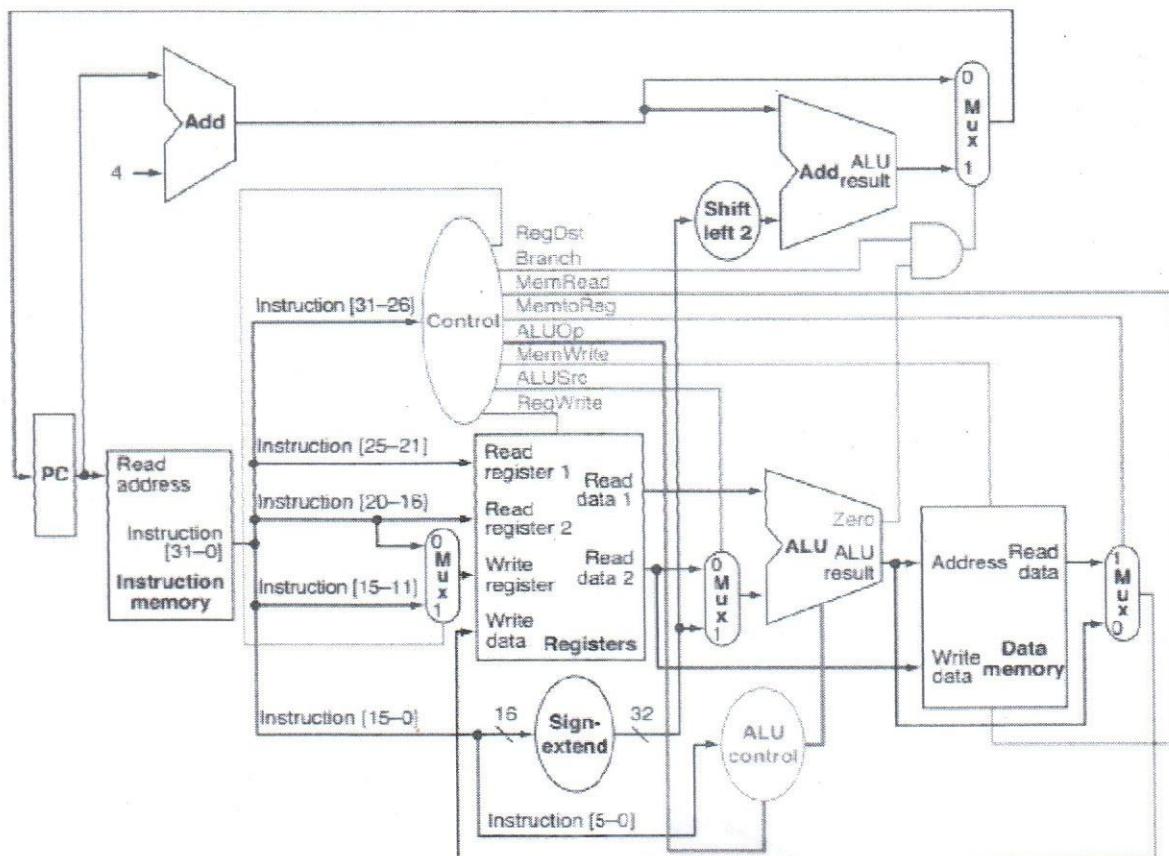
- i. Given a program with  $10^6$  instructions divided into classes as follows: 10% class A, 20% class B, 50% class C, and 20% class D, which implementation is faster?
- ii. What is the global CPI for each implementation?
- iii. Find the clock cycles required in both cases.

7. a) What are the different instruction formats in MIPS architecture? Give appropriate examples for each. Also mention the name and size of the fields of each of the instruction formats. 10
- b) Translate the following problems from MIPS to C. Assume that the variables *f*, *g*, *h*, *i*, and *j* are assigned to registers \$s0, \$s1, \$s2, \$s3, and \$s4, respectively. Assume that the base address of the arrays A and B are in registers \$s6 and \$s7, respectively. 10
- i.    sub \$s0, \$s0, \$s1  
      sub \$s0, \$s0, \$s3  
      add \$s0, \$s0, \$s1  
 ii.    addi \$t0, \$s6, 4  
      add \$t1, \$s6, \$0  
      sw \$t1, 0(\$t0)  
      lw \$t0, 0(\$t0)  
      add \$s0, \$t1, \$t0
- c) Briefly describe the five fields of R-type instruction. 5
8. a) What are the five stages of a pipeline? Briefly explain each. 10
- b) Assume the miss rate of an instruction cache is 2% and the miss rate of the data cache is 4%. If a processor has a CPI of 2 without any memory stalls and the miss penalty is 100 cycles for all misses, determine how much faster a processor would run with a perfect cache that never missed. Assume the frequency of all loads and stores is 36%. 10
- c) Briefly explain what is the clocking methodology. What is the difference between interrupt and exception? 3+2

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### Appendix

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**Islamic University of Technology**  
 Organisation of Islamic Cooperation (OIC)  
**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION****WINTER SEMESTER, 2018-2019****Duration: 3 Hours****Full Marks: 150****CSE 4307: Database Management Systems**

Programmable calculators are not allowed. Do not write anything on the question paper. There are 8(eight) questions. **Question No. 7 and 8 are compulsory to answer.** Answer any 4(four) from the remaining questions. Figures in the right margin indicate marks.

1. (a) One of the major drawbacks of traditional file processing system is the *difficulty to access data*. Explain it with a suitable example. Mention some widely used applications of modern database systems. [10]
- (b) A major purpose of a database system is to provide users with an abstract view of the data. Explain the concept of different types of *data abstraction* in modern database systems. [10]
- (c) What are projection and selection? Does the order of these operations matter in the final result? Explain with example. [05]
2. (a) Define and differentiate between Data-Definition Language (DDL) and Data-Manipulation Language (DML). [05]
- (b) Define super key, candidate key, primary key and foreign key. Consider the following system description of a typical library automation:  
  
*There are books on different subjects such as Computer Science, Mechanical Engineering, Education etc. Each book have information such as Book Title, Author Name, Publisher Name, Publishing Year. There are a number of copies of a single book (e.g Database System Concepts, 100 copies). There are a number of departments in the University. Each department runs a number of programs. The students information system stores basic information of each students such as name, date of birth, address, father name, department name (i.e. CSE, EEE), program name (i.e. B.Sc. or M.Sc.). Students can borrow book and return book.*  
 Your tasks are:
  - i. Design the E-R diagram and its equivalent DDL statements.
  - ii. In each case determine the primary key and foreign key.
- (c) What is the difference between inner join and outer join? Explain left outer join and right outer join with suitable examples. [05]
3. (a) Followings are the requirements of some tables. Each field is separated by comma (,) and additional requirements are stated in brackets [ ]. [10]
  - **Departments**(ID primary key, Name of dept [Can not be empty], Establishment Year)
  - **Employees**(ID primary key [it is exactly a 9-digit number without any decimal part], Name [20 characters long but it can be in any language other than English], Date of birth [must not be empty and it can be less than 01-01-1960], Dept [foreign key of departments entity and it can not be empty], Blood Group [must be any one from A+,A-, B+,B-,AB+,AB-])
  - **Salary**(EmpID [foreign key of Employees entity], Date of Payment, Amount)

Your tasks are:

- i. Create the tables using standard SQL.
- ii. Now you forgot to include Salary (per month) and Join Date of the Employees. How can you solve this problem?

(b) Write the SQL for the following queries: [10]

- i. Find out the name and date of birth of all Employees who joined in the last 3 months (i.e. 90 days).
- ii. Find out the name, date of birth and name of the department of all Employees who joined in the last 3 months (i.e. 90 days).
- iii. Generate a list containing department name and its total employees.
- iv. Generate a list containing department name and its total employees but include the department with at least 20 employees.
- v. Generate a list containing department name and its total employees but include the department with at least 20 employees and whose departmental average salary is greater than 20000.

(c) What is cardinality? Briefly explain different types of cardinality. [05]

4. (a) Null value introduces a number of problems in arithmetic operations in SQL statements. Justify with suitable example. [10]

(b) What is jdbc? Consider the entity **Emp**(ID,Name,Address,Dept). Write a java program that will print the name, address and dept of those employees who work in 'Accounts' department. Assume that jdbc driver is already loaded. Write only the relevant part of the code. [10]

(c) There are four integrity constraints on single relation. Name them with suitable examples. [05]

5. (a) What is the domain of attribute? Explain different types of attributes used in E-R model. [05]

(b) Consider the following description:

*XYZ is a large company comprising about 5000 employees. To automate the Human Resource 2 programmers are hired. Mr. Simple, one of the programmers, designs the ID of employee as simple numbers such as 000001, 000002 and so on. Mr. Complex, another programmer, designs the ID for the format: DEPTCODE-DESIGNATIONCODE-JOINDATE-SEQUENCENUMBER, (i.e. ACCOUNTS-MANAGER-01JAN2017-001).*

Your tasks are:

- i. Criticize the above designs mentioning the strength and weakness of each option.
- ii. Propose your solution minimizing the weaknesses you have just mentioned.

(c) Classify the constraints on generalization or specialization based on the followings: [10]

- i. Attribute of higher-level entity determines lower-level entity membership
- ii. The number of branching in its lower-level entity
- iii. Completeness

6. (a) What is the purpose of Normal Forms in database design? Explain the concept of 1<sup>st</sup> Normal Form with example. [05]

(b) Mention the conditions of Boyce-Codd Normal Form (BCNF). Cite two examples both valid and invalid BCNF schema. Also mention how you will decompose an invalid BCNF into several valid BCNF schema. [10]

(c) Consider the following schema and records (as presented in table 1) for a student information management system:

*students(ID, Name, Date of Birth, Country Name, Capital Name, Total Population)*

Your tasks are:

- i. Verify if the given schema is in BCNF.
- ii. If it is not in BCNF then decompose it as directed by the BCNF algorithm.

Table 1: Records for Question No. 6.(c)

| ID | Name | DOB    | Country_Name | Capital | Population (in m) |
|----|------|--------|--------------|---------|-------------------|
| 1  | a    | 1-1-87 | Bangladesh   | Dhaka   | 160               |
| 2  | b    | 1-2-85 | Afghanistan  | Kabul   | 32                |
| 3  | c    | 1-3-81 | Bangladesh   | Dhaka   | 160               |
| 4  | d    | 1-3-81 | Cameroon     | Yaounde | 17                |
| 5  | e    | 1-4-77 | Afghanistan  | Kabul   | 32                |

### 7. (Compulsory)

Consider the following scenario:

*ABC is a large bank with few hundreds of branches located at different parts of the country. Customers must provide their profile information such as Name, Date of Birth, Address before opening any account. Once a customer's profile is available he/she can open multiple accounts reusing the profile information. After opening account regular transactions are made. There are two types of transactions such as withdraw and deposit.*

*Bank offers loans. Only existing customers who have valid accounts are primarily eligible for getting a loan. There are 3 types of loan schemes such as Platinum, Gold and Silver . Each loan has its own properties as described in table 2.*

Table 2: Properties of loan schemes for Question No. 7

| Loan Scheme | No. of Instalment | Interest Rate (per year) | Eligibility                                                                                          |
|-------------|-------------------|--------------------------|------------------------------------------------------------------------------------------------------|
| Platinum    | 100               | 5                        | Total Transaction (i.e. add both types of transactions) in the last 12 months must be $\geq 2000000$ |
| Gold        | 75                | 8                        | Total Transaction in the last 12 months must be between 2000000 and 1500000                          |
| Silver      | 50                | 12                       | Total Transaction in the last 12 months must be between 1500000 and 1000000                          |

Your tasks are:

- (a) Design the table definitions and issue the required DDLs. Additional assumptions are welcome in design phase. [08]

- (b) Write a function to assign a customer to a specific category of loans as mentioned. (assume that each customer makes regular transactions such as deposit and withdraw). [08]

*Input: Account No. Output:Rejected or Accepted, if Accepted it should also show which type of loan can be granted based on the Eligibility parameter as described in table.*

- (c) Once a customer is assigned to a specific loan scheme, write a procedure to schedule the loan. Assume each loan must be paid after 6 months interval. [09]

*Input: Account No, Loan Scheme, Total Amount, Starting Date. Output: It will schedule x number of equal instalments based on Total Amount and No. of Instalment of that particular loan scheme. The schedule information should include: account no, loan scheme, Instalment no.(starts from 1 to x),Instalment amount (i.e. total amount will be equally distributed), Payment Date (i.e. after every 6 months from the Starting Date), Payment Status. All fields except Payment Status should be initialised by the procedure. Payment Status should be set to null.*

## 8. (Compulsory)

- (a) Suppose you have issued an UPDATE statement to a table *citizens* as mentioned in Question No. 8.(c) with some WHERE CLAUSE (as you like). [05]

Write an anonymous block that will execute the above UPDATE statement. If none of the records are affected by the statement then it will print *NO RECORDS ARE UPDATED*, otherwise it will count the total number of updated records (i.e. X) and will print *A TOTAL OF X RECORDS ARE UPDATED*.

- (b) What is the basic difference between row-level trigger and statement-level trigger? Explain with example. [05]

- (c) Consider the table *citizens(id, name, dob, salary)*. The Government of Bangladesh (GOB) has created one fund of total BDT *total\_aid\_amount*. [15]

GOB wants to ensure (but can not guarantee) each citizen receives an amount *gob\_allownace* such that after receiving it his/her total earning (i.e. *salary + gob\_allownace*) is equal to the average income of the country (average is computed before any *gob\_allownace* is given). The citizens having more than the average salary of the country are not eligible for this scheme.

For this purpose GOB invites applications from needy and interested people. The applications are stored in *applied(citizen\_id), date of application* table (assume only the valid persons apply). The citizens who have not applied will not be considered even his/her salary is very low.

The citizen (who applied) with the lowest salary will get the highest priority to receive *gob\_allownace* and *gob\_allownace* amount is determined by the difference of his/her salary and average salary of the citizen. GOB can not ensure sufficient fund for all needy citizens. So the process terminates whenever the fund is exhausted (i.e. *total\_aid\_amount=0* or *total\_aid\_amount is less than the difference of the average salary and the salary of the particular citizen*).

When a citizen receives *gob\_allownace* an appropriate update of *citizens* table should be made.

- Your task is to write a procedure *distribute\_allowance* satisfying the above requirements. The procedure will take only one IN parameter i.e. *total\_aid\_amount*. [Hint: use explicit cursor to select the candidates as per the description]

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4309: Theory of Computing**

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

**There are 8 (eight) questions. Answer any 6 (six) of them.**

**Figures in the right margin indicate marks.**

- |       |                                                                                                  |     |
|-------|--------------------------------------------------------------------------------------------------|-----|
| 1. a) | What is the difference between empty string and empty language?                                  | 2   |
| b)    | Explain the differences among $\Sigma$ , $\Sigma^0$ and $\Sigma^1$ .                             | 3   |
| c)    | Give formal definition of a Finite Automaton. Explain $\delta$ for DFA, NFA and $\epsilon$ -NFA. | 7   |
| d)    | Consider the transition table of a DFA given in Table 1:                                         | 7+6 |

Table 1: Transition table of a DFA for Question 1.d

|     | 0 | 1 |
|-----|---|---|
| → A | B | E |
| B   | C | F |
| C   | D | H |
| D   | E | H |
| E   | F | I |
| F   | G | B |
| G   | H | B |
| H   | I | C |
| * I | A | E |

- i. Draw the table of distinguishabilities for this automaton.
- ii. Construct the minimum-state equivalent DFA.

- |       |                                                                                                                                                      |    |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 2. a) | Explain the terms in one sentence:                                                                                                                   | 2  |
| i.    | Decidability                                                                                                                                         |    |
| ii.   | Intractability                                                                                                                                       |    |
| b)    | Design an NFA for the language $L = \{a^n \mid n \text{ is even or divisible by } 3\}$ . Try to use $\epsilon$ -transitions to simplify your design. | 8  |
| c)    | Compute the $\epsilon$ -closure of each state and convert the $\epsilon$ -NFA of Table 2 to its equivalent DFA.                                      | 15 |

Table 2: Transition table of an  $\epsilon$ -NFA for Question 2.c

|     | $\epsilon$  | a           | b           | c           |
|-----|-------------|-------------|-------------|-------------|
| → p | $\{q, r\}$  | $\emptyset$ | $\{q\}$     | $\{r\}$     |
| q   | $\emptyset$ | $\{p\}$     | $\{r\}$     | $\{p, q\}$  |
| * r | $\emptyset$ | $\emptyset$ | $\emptyset$ | $\emptyset$ |

- |       |                                                                                                          |     |
|-------|----------------------------------------------------------------------------------------------------------|-----|
| 3. a) | What are the operators of regular expression? Mention the order of precedence followed by the operators. | 2+1 |
| b)    | Convert the regular expression $(1^*01^*0)^*1^*$ to NFA with $\epsilon$ -transitions.                    | 10  |
| c)    | Write the regular expressions for the following languages:                                               | 2×6 |
| i.    | $L = \{ w \mid w \in \{0, 1\} \text{ and }  w  \text{ is multiples of } 3\}$                             |     |
| ii.   | $L = \{ w \mid w \in \{0, 1\} \text{ and no two consecutive } 0's\}$                                     |     |

4. Consider the transition table of a DFA given in Table 3.

Table 3: Transition table of a DFA

|                   | 0     | 1     |
|-------------------|-------|-------|
| $\rightarrow q_0$ | $q_0$ | $q_1$ |
| * $q_1$           | $q_0$ | $q_1$ |

- a) Describe the language of the DFA. 2  
 b) Convert the DFA to its equivalent Regular Expression using transitive method. Simplify each expression as much as possible. 18  
 c) Convert the DFA to its equivalent Regular Expression using state elimination method. 5
5. a) Show the computation of the NFA (Figure 1) that makes the input 1011 be accepted. 6

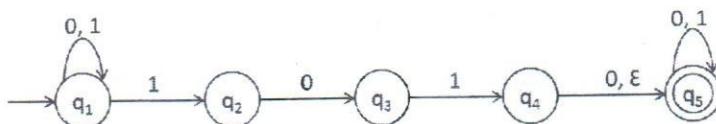


Figure 1: State diagram of an NFA

- b) Suppose  $h$  is the homomorphism from the alphabet  $\{0, 1, 2\}$  to the alphabet  $\{a, b\}$  defined by: 9  

$$\begin{aligned} h(0) &= a \\ h(1) &= ab \\ h(2) &= ba \end{aligned}$$
  
 If  $L_1 = \{10, 02, 0120, 21120\}$ ,  $L_2 = 01^*2$  and  $L_3 = \{ababa\}$ , what is  $h(L_1)$ ,  $h(L_2)$  and  $h^{-1}(L_3)$ ?  
 c) Using pumping lemma for regular language, show that the language  $L = \{0^n1^n \mid n \geq 1\}$  is not regular. 10

6. a) Design Context Free Grammar for the following languages where  $T = \{a, b\}$ : 2×7  
 i. The set of all strings where no string has "ba" as substring.  
 ii. The set of all strings with an equal number of a's and b's.

- b) Consider the following grammar: 6

$$\begin{aligned} S &\rightarrow AB \mid C \\ A &\rightarrow aAb \mid ab \\ B &\rightarrow cBd \mid cd \\ C &\rightarrow aCd \mid aDd \\ D &\rightarrow bDc \mid bc \end{aligned}$$

Find the followings from the grammar for the string "abcd":

- i. Right most derivation  
 ii. Parse tree

- c) Show that the grammar in Question 6.b. is ambiguous on the string "aabbccdd". 5

7. a) Explain the 7-tuple definition of Pushdown Automata (PDA). When can we define a PDA with 6 tuple? 8

- b) Suppose the PDA  $P = (\{q, p\}, \{0, 1\}, \{Z_0, X\}, \delta, q, Z_0, \{p\})$  has the following transition function: 7

1.  $\delta(q, 0, Z_0) = \{(q, XZ_0)\}$
2.  $\delta(q, 0, X) = \{(q, XX)\}$
3.  $\delta(q, 1, X) = \{(q, X)\}$
4.  $\delta(q, \epsilon, X) = \{(p, \epsilon)\}$
5.  $\delta(p, \epsilon, X) = \{(p, \epsilon)\}$
6.  $\delta(p, 1, X) = \{(p, XX)\}$
7.  $\delta(p, 1, Z_0) = \{(p, \epsilon)\}$

Starting from the initial ID  $(q, w, Z_0)$ , show all the reachable ID's when the input is 010

- c) Design a PDA to accept the language  $L = \{a^i b^j c^k \mid i = j \text{ or } j = k\}$ . Draw the transition diagram for the constructed PDA. 10
8. a) What is Chomsky Normal Form (CNF)? Explain. 2  
 b) What is ambiguous grammar? Explain with example. 3  
 c) Begin with the grammar:  $4 \times 5$
- $$S \rightarrow aAa \mid bBb \mid \epsilon$$
- $$A \rightarrow C \mid a$$
- $$B \rightarrow C \mid b$$
- $$C \rightarrow CDE \mid \epsilon$$
- $$D \rightarrow A \mid B \mid ab$$
- i. Eliminate  $\epsilon$  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.

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**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**DURATION: 3 Hours**

**WINTER SEMESTER, 2018-2019**

**FULL MARKS: 150**

**Math 4341: Linear Algebra**

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

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

1. a) Find out all four subspaces of the given matrix A and find out the complete solution for  $Ax = b$ . 17

$$A = \begin{bmatrix} 2 & 4 & 6 & 4 \\ 2 & 5 & 7 & 6 \\ 2 & 3 & 5 & 2 \end{bmatrix} \quad \text{and} \quad b = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} = \begin{bmatrix} 4 \\ 3 \\ 5 \end{bmatrix}$$

- b) For the given matrix in 1.(a) find out the dimensions of all four subspaces. 4
- c) With the calculated subspaces, show that nullspace is perpendicular to the row space and left nullspace is perpendicular to the column space. 4
2. a) Define vector space and subspaces with appropriate examples. Mention the types of vector subspaces of  $\mathbf{R}^2$  and  $\mathbf{R}^3$  space. 5
- b) Prove that K is invertible if  $a \neq 0$  and  $a \neq b$  for the given matrix K below. 10

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

- c) Compute L and U for the symmetric matrix A. Also find four conditions on a, b, c, d to get A=LU with all four pivots. 10

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

3. a) Generally when we multiply two matrices by hand (satisfying dimensions), we multiply rows with column. How can we get the same result by multiplying in the other way around i.e. column times row? Mention the special property of the sub-matrix that you get by multiplying a single column with a single row. 7
- b) For which right sides (find a condition on  $b_1, b_2$ , and  $b_3$ ) are these systems solvable? Also find out the rank of the linear systems given. 10

i. 
$$\begin{bmatrix} 1 & 4 & 2 \\ 2 & 8 & 4 \\ -1 & -4 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix}$$

ii. 
$$\begin{bmatrix} 1 & 4 \\ 2 & 9 \\ -1 & -4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix}$$

- c) Reduce the following matrix to its ordinary echelon form and then identify its free variables and pivot variables. 8

$$\begin{bmatrix} 1 & 2 & 2 & 4 & 6 \\ 1 & 2 & 3 & 6 & 9 \\ 0 & 0 & 1 & 2 & 3 \end{bmatrix}$$

4. a) Derive the formula of projection of a vector  $b$  onto the column space of a matrix  $A$ . If  $P$  is the projection matrix, show that  $P = P^T$  and  $P^2 = P$ . 10
- b) What linear combination of  $(1,2,-1)$  and  $(1,0,1)$  is closest to  $b = (2,1,1)$ ? 8
- c) With the help of appropriate diagram, for a linear system  $Ax = b$ , describe how particular solution and nullspace solution maps a matrix  $A$  to  $b$ . 7
5. a) Prove that  $A^T A$  is invertible if and only if  $A$  has linearly independent columns. 8
- b) Project vector  $b = (0,8,8,20)$  onto the line through vector  $a = (1,1,1,1)$ . Find out the projection of vector  $b$  on vector  $a$ . Show that the error vector is perpendicular to vector  $a$ . 8
- c) Find  $q_1, q_2, q_3$  (orthonormal vectors) as combinations of  $a, b, c$  (independent columns). Then write  $A$  as  $QR$  where  $Q$  and  $R$  have their usual meanings. 9
- $$A = \begin{bmatrix} 1 & 2 & 4 \\ 0 & 0 & 5 \\ 0 & 3 & 6 \end{bmatrix}$$
6. a) Define orthonormal vectors. Why it is easier to work with orthonormal vectors while working with projection? Explain with appropriate justification. 6
- b) Find the determinants of the following matrices  $U$  and  $U^{-1}$  and  $U^3$ . Where  $U$  is given as 9
- $$U = \begin{bmatrix} 1 & 2 & 3 & 0 \\ 2 & 6 & 6 & 1 \\ -1 & 0 & 0 & 3 \\ 0 & 2 & 0 & 7 \end{bmatrix}$$
- c) Using properties of determinants, from the formula  $AC^T = (\det A)I_n$  show that  $\det C = (\det A)^{n-1}$  10
7. a) With the help of the properties of the determinant of a matrix, prove that for any matrix  $A$ ,  $\det(A) = \det(A^T)$ . 6
- b) Use Cramer's Rule with ratios  $x_j = \frac{\det B_j}{\det A}$  to solve the given linear system below. 12
- $$\begin{aligned} 2x_1 + 6x_2 + 2x_3 &= 0 \\ 1x_1 + 4x_2 + 2x_3 &= 0 \\ 5x_1 + 9x_2 + 0x_3 &= 1 \end{aligned}$$
- c) A box has edges from  $(0,0,0)$  to  $(3,1,1)$  and  $(1,3,1)$  and  $(1,1,3)$ . Find the volume of the box. 7
8. a) Find the eigenvalues and eigenvectors of the following  $3 \times 3$  matrix  $M$ . 9
- $$M = \begin{bmatrix} 1 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 1 \end{bmatrix}$$
- b) Start from  $u_0 = (1,0)$ , Compute  $u_k$  when  $S$  and  $\Lambda$  contain these eigen vectors and eigen values. 8
- $$A = \begin{bmatrix} 1 & 2 \\ 1 & 0 \end{bmatrix}, \quad \Lambda = \begin{bmatrix} 2 & 0 \\ 0 & -1 \end{bmatrix}, \quad S = \begin{bmatrix} 2 & 1 \\ 1 & -1 \end{bmatrix}$$
- c) Find the Fibonacci number  $F_{98}$  using eigenvalues and eigenvectors. 8

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**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**Math 4341: Linear Algebra**

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

**There are 8 (eight) questions. Question no. 3 and 4 is mandatory to answer.**

**Answer any 4 (four) from the remaining.**

**Figures in the right margin indicate marks.**

$$B = \begin{bmatrix} 1 & 3 & 1 & 2 & 5 \\ 2 & 6 & 4 & 8 & 10 \\ 0 & 0 & 2 & 4 & 0 \end{bmatrix} x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{bmatrix} b = \begin{bmatrix} 1 \\ 3 \\ 1 \end{bmatrix} m = \begin{bmatrix} m_1 \\ m_2 \\ m_3 \end{bmatrix}$$

**(Use these vectors and matrices to answer the question from 1-3)**

1. a) Find out the correct elimination matrix  $E$  to convert the matrix  $B$  into its upper triangular form  $EB = U$ . Also factorize  $B$  into  $LU$  format. 13  
 b) For finding the Inverse of a matrix using Gauss-Jordan method, first the augmented matrix is taken as  $[A I]$ . Then the target is to convert  $A$  into  $I$  which brings  $A^{-1}$  in the place of the augmented  $I$  simultaneously.  
 Explain the reason behind the appearing of  $A^{-1}$  in the place of the augmented  $I$ . 6  
 c) Explain whether the following statements are True or false (with a reason or an example): 1.5×4
  - i. Any  $m$  by  $n$  matrix with  $\text{rank} = m$  has solution for every  $Ax = b$ .
  - ii. A rank-one matrix might have dependent rows.
  - iii. The left Null-space can be empty although the Null-space has special solutions.
  - iv. A Matrix-space consisting of all possible  $m$  by  $n$  matrices has dimension  $m$  or  $n$ .
2. a) What is the condition on the vector  $m$  for the system  $Bx = m$  to have a solution? 6  
 b) Find out the complete solution of the linear system  $Bx = b$ . 13  
 c) i. Do the vectors lying on the line  $2x + y = 7$  form a subspace? Justify your answer. 6  
 ii.  $S = \{x, y \in R: x > 0, y > 0 \text{ or } x < 0, y < 0\}$  Does this set of vectors form a valid subspace? Justify your answer.

**[Mandatory]**

3. a) Prove that, if a matrix  $A$  has independent columns,  $A^T A$  is invertible. 7  
 b) Find out the basis and dimension for the four fundamental subspaces associated with the matrix  $B$ . Also comment about the shapes of the four spaces. 13  
 c) Explain why  $v = (1, 3, 1, 2, 5)$  cannot be a row of  $B$  and also in the Null-space at the same time. 5

**[Mandatory]**

4. a) Suppose a plane in  $R^n$  is described by a matrix A. Calculate the *projection* and *error* for any vector ' $b$ ' when:
- $b \in N(A^T)$
  - $b \perp N(A^T)$
- b) Using the properties of determinant, for any  $n \times n$  matrix A, Prove that,  $\det(A) = \det(A^T)$ . 8
- c) While taking the projection( $p$ ) of a vector( $b$ ) on a plane, what are the conditions when the projection will produce an eigenvector? Write the eigenvalues and eigenvectors for those cases. 7
5. a) What linear combination of  $a_1 = (1, 2, -1)$  and  $a_2 = (1, 0, 1)$  is closest to  $b = (2, 1, 1)$ ? What will be the error vector( $e$ )? 10
- b) Find the orthonormal vectors  $A, B, C$  by *Gram-Schmidt* process from  $a, b, c$ :  
 $a = (1, -1, 0, 0)$     $b = (0, 1, -1, 0)$     $c = (0, 0, 1, -1)$  10
- c) A box has edges from  $(0, 0, 0)$  to  $(3, 1, 1), (1, 3, 1), (1, 1, 3)$ . Find the volume of the box. 5
6. a) Derive the formula of the Projection Matrix( $P$ ) for projecting any vector ' $b$ ' onto a plane. Also prove that, '*Projecting the vector ' $b$ ' twice onto the same plane will not change the projection.*' 10+5
- b) With  $y = 0, 8, 8, 20$  at  $x = 0, 1, 2, 3$ , find out the equation of the '*best fit*' straight line through these points. What is the minimum value  $E = e_1^2 + e_2^2 + e_3^2 + e_4^2$  10
7. a) If a 5 by 5 matrix has  $\det(A) = \frac{1}{8}$ , find  $\det(-A), \det(A^2), \det(5A), \det(A^{-1}), 2\det(A), \det(A^{-1}A)$ . 1.5 \times 6
- b) Find the determinant of the following matrix in **three** different ways. 12
- $$\begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 3 & 4 & 5 \\ 5 & 4 & 0 & 3 \\ 2 & 0 & 0 & 1 \end{bmatrix}$$
- c) i. Given  $x$  an eigenvector, what is the way to find the eigenvalue( $\lambda$ )?  
ii. Given  $\lambda$  an eigenvalue, what is the way to find the eigenvector( $x$ )? 4
8. a) Find the eigenvalues and eigenvectors of the matrix 20
- $$A = \begin{bmatrix} 1 & -3 & 3 \\ 3 & -5 & 3 \\ 6 & -6 & 4 \end{bmatrix}$$
- Also find the *Trace* and *Determinant* of the matrix using the eigenvalues.
- b) The basic equation of eigenvalue( $\lambda$ ) is  $Ax = \lambda x$ . What will be the eigenvalue of  $A^n$ ? Justify with proper mathematical derivation. 5

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**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.**  
**There are 8 (eight) questions. Answer 6 (six) of them (You must answer Question no. 7 and 8)**  
**Figures in the right margin indicate marks.**

1. a) Assume that you are in a computer shop to buy a new computer for yourself. As you're a 12  
passionate gamer, you want to afford the fastest PC. How many factors you should consider  
while buying the desired one? Explain about these factors elaborately.
- b) Show the classification of the computer's memory. Under which branch does the DRAM 8  
and SRAM fall? What is their main difference?
- c) Explain the problems of using the forward declaration of user-defined functions. 5
  
2. a) Assume that you are setting up an office space. While connecting the PCs to the internet, 15  
you have to consider the following scenarios:
  - A lot of employees would sit in the same room, as the space is small.
  - You're running on a low budget to set-up the connection.
  - As the space is small, you cannot use a lot of cables as it would look congested.
  - Crashing down of one PC should not affect the others.
 What should be the best kind of network topology to use in this scenario? Give a comparative analysis.
- b) What is the best use of tape drives? 3
- c) Implement a user-defined function called `return_length()` that fulfills the functionality of 7  
the `strlen()` library function. What would be the parameters of this function?
  
3. a) What is an 'interrupt'? How does an OS utilize the interrupt? Explain elaborately. 8
- b) If the multiplier of a CPU is 2.5 and the processor speed is 1.8 GHz, what would be the bus 6  
speed of CPU? What can you determine about the PC from the 'multiplier' here?
- c) Why do we need text codes? How are ASCII and Extended ASCII connected? 6
- d) If you want to copy 'Bangla' from the string 'Bangladesh', what library function should you 5  
use? Demonstrate briefly.
  
4. a) What is used by the Solid State Devices (SSD) to hold data? How does it utilize the best 8  
features of RAM and ROM?
- b) State the four main responsibilities of an OS. What is a 'clipboard' and how is it used? 7
- c) Why fiber-optic cable is the dominant type of cable now-a-days? Explain briefly. 5
- d) Write a C program to find the total number of vowels in a string given as input by a user. 5
  
5. a) Perform Binary Subtraction: +5 & -10 7
- b) There are four types of OS. What are they? Describe how they work. 6
- c) How does a Firewall and an Anti-virus software enhance an OS? 5

- d) Is there any bug in the following code snippet? If yes, Debug and rewrite the code.

```
#include<stdio.h>
double volume(int a, int b, int c) {
 int volume;
 volume = a * b * c;
 return volume;
}
int main() {
 double vol;
 vol = volume(5, 3);
 printf("%f", vol);
 return 0;
}
```

7

6. a) A palindromic number is a number that remains the same when its digits are reversed, for example: 16461. Write a C program to check if an integer is Palindromic or not. Your program should take input of an integer and print 'Yes' if the number is palindromic and print 'No' otherwise. 8
- b) State the two factors that the average access time of data depends on. Is it possible to optimize the average access time? If your answer is 'yes', explain the methods of doing it. 10
- c) What do you understand by the term 'UART'? Where is it used? Explain with proper pictorial demonstration. 7

#### [Mandatory]

7. Assume your teacher of the CSE course has finished checking your mid scripts and he wants to store the marks in an array and also wants to perform some operations on it. Suppose your class has only 10 students and the student IDs start from 1 and ends at 10. As you are an avid programmer, he calls you up for the job and you are given the following tasks:

- a) Save the mid marks of the students in an array called *mid\_marks* in a sequential order of your student IDs. So, the mark of the student with ID 1 would be the first entry of the array, and the last entry of that array would be of the student with ID 10. The teacher wants to give input of the marks himself. 5
- b) After giving the input into the array, find the maximum and minimum marks and also find out the student IDs of the persons who got the maximum and minimum marks. 6
- c) Check if any two students got the same mark or not. If yes, print the IDs and their achieved marks. Considering only one case is enough. 6
- d) The teacher wants to give 10% bonus marks to all students whose student IDs are prime numbers. Implement this and save the new marks in the same array. Your code should contain the mechanism of finding out which IDs are prime numbers. 8

5

6

6

8

#### [Mandatory]

8. a) Assume it's a hot day and you have prepared some fruit juice for your friends. But you can only measure the juice in ounces and your friends only understand measurements in cups. 8 ounces makes a cup. Write a C program that converts ounces to cups so that your friends can understand your method of measurement. Use a function called *juice\_dilemma()* to perform the conversion. Call it with the number of ounces and have it return the number of cups inside the main function. 10

| Sample Input | Sample Output |
|--------------|---------------|
| 4            | .50           |
| 12           | 1.50          |

7

- b) State the reason behind the naming of 'magnetic' storage device. How is data stored on this type of devices? 7
- c) What do you understand by a volatile and non-volatile chip? Give an example for each of the kind. 4
- d) If a computer's clock speed is 800 MHz and another computer's clock speed is 1.2 GHz, which computer you think would be faster? Give proper explanation. 4

4

4

4

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4501: Operating Systems**

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

**There are 8 (eight) questions. Answer any 6 (six) of them.**

**Figures in the right margin indicate marks.**

1. a) Consider the following segment table:

7

| Segment | Base | Length |
|---------|------|--------|
| 0       | 219  | 600    |
| 1       | 2300 | 14     |
| 2       | 90   | 100    |
| 3       | 1327 | 580    |
| 4       | 1952 | 96     |

What are the physical addresses for the following logical addresses?

- a) 0,430 b) 1,10 c) 2,500 d) 3,400 e) 4,112

- b) Consider a paging system with the page table stored in memory:

5

- i. If a memory reference takes 200 nanoseconds, how long does a paged memory reference take?
- ii. If we add TLBs, and 75 percent of all page-table references are found in the TLBs, what is the effective memory reference time? (Assume that finding a page-table entry in the TLBs takes zero time if the entry is there.)

6

- c) On a system with paging, a process cannot access memory that it does not own. Why? How could the operating system allow access to other memory? Why should it or should it not?

7

2. A page-replacement algorithm should minimize the number of page faults. We can achieve this minimization by distributing heavily used pages evenly over all of memory, rather than having them compete for a small number of page frames. We can associate with each page frame a counter. The counter value is a number representing the number of pages associated with this frame that will be used in the future. Therefore, the addition of a page and the very last use of a page change the counter value. Then, to replace a page, we can search for the page frame with the smallest counter value.

6

- a) Define a page-replacement algorithm using this basic idea. Specifically address the problems of (i) what the initial value of the counters is, (ii) when counters are increased, (iii) when counters are decreased, and (iv) how the page to be replaced is selected.

- b) How many page faults occur for your algorithm for the following reference string with four-page frames?

7

1, 2, 3, 4, 5, 3, 4, 1, 6, 7, 8, 7, 8, 9, 7, 8, 9, 5, 4, 5, 4, 2.

- c) What is the minimum number of page faults for an optimal page replacement strategy for the reference string in part (b) with four-page frames?

12

3. Consider the following snapshot of a system. There are no outstanding unsatisfied requests for resources.

|  | available |    |    |    |
|--|-----------|----|----|----|
|  | r1        | r2 | r3 | r4 |
|  | 2         | 1  | 0  | 0  |

| process | current allocation |    |    |    | maximum demand |    |    |    | still needs |    |    |    |
|---------|--------------------|----|----|----|----------------|----|----|----|-------------|----|----|----|
|         | r1                 | r2 | r3 | r4 | r1             | r2 | r3 | r4 | r1          | r2 | r3 | r4 |
| p1      | 0                  | 0  | 1  | 2  | 0              | 0  | 1  | 2  |             |    |    |    |
| p2      | 2                  | 0  | 0  | 0  | 2              | 7  | 5  | 0  |             |    |    |    |
| p3      | 0                  | 0  | 3  | 4  | 6              | 6  | 5  | 6  |             |    |    |    |
| p4      | 2                  | 3  | 5  | 4  | 4              | 3  | 5  | 6  |             |    |    |    |
| p5      | 0                  | 3  | 3  | 2  | 0              | 6  | 5  | 2  |             |    |    |    |

- a) Is this system currently in a safe or unsafe state? Why?  
 b) Is this system currently deadlocked? Why or why not?  
 c) Which processes, if any, are or may become deadlocked?  
 d) If a request from p3 arrives for (0, 1, 0, 0), can that request be safely granted immediately? In what state (deadlocked, safe, unsafe) would immediately granting that whole request leave the system? Which processes, if any, are or may become deadlocked if this whole request is granted immediately?

7  
6  
3  
9

4. a) Race conditions are possible in many computer systems. Consider a banking system with two functions: *deposit(amount)* and *withdraw(amount)*. These two functions are passed the amount that is to be deposited or withdrawn from a bank account. 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 and propose a solution to prevent the race condition from occurring.  
 b) The first known correct software solution to the critical-section problem for two processes was developed by Dekker. The two processes,  $P_0$  and  $P_1$ , share the following variables:

10

```
boolean flag[2]; /* initially false */
int turn;
```

The structure of process  $P_i$  ( $i == 0$  or  $1$ ) is given below; the other process is  $P_j$  ( $j == 1$  or  $0$ ).

```
do {
 flag[i] = TRUE;
 while (flag[j]) {
 if (turn == j) {
 flag[i] = false;
 while (turn == j)
 ; // do nothing
 flag[i] = TRUE;
 }
 }
}
```

// critical section

```
turn = j;
flag[i] = FALSE;
// remainder section
```

} while (TRUE);

15

Prove that the algorithm satisfies all three requirements for the critical-section problem.

5. Assume that a finite number of resources of a single resource type must be managed. Processes may ask for a number of these resources and —once finished—will return them. As an example, many commercial software packages provide a given number of licenses, indicating the number of applications that may run concurrently. When the application is started, the license count is decremented. When the application is terminated, the license count is incremented. If all licenses are in use, requests to start the application are denied. Such requests will only be granted when an existing license holder terminates the application and a license is returned.

The following program segment is used to manage a finite number of instances of an available resource. The maximum number of resources and the number of available resources are declared as follows:

```
#define MAX_RESOURCES 5
int available_resources = MAX_RESOURCES;
```

When a process wishes to obtain a number of resources, it invokes the `decrease_count()` function:

```
/* decrease available resources by count resources */
/* return 0 if sufficient resources available, */
/* otherwise return -1 */
int decrease_count(int count) {
 if (available_resources < count)
 return -1;
 else {
 available_resources -= count;
 return 0;
 }
}
```

When a process wants to return a number of resources, it calls the `increase_count()` function:

```
/* increase available resources by count */
int increase_count(int count) {
 available_resources += count;
 return 0;
}
```

The preceding program segment produces a race condition. Do the following:

- |                                                                                                                                                                                                              |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| a) Identify the data involved in the race condition. Show the race condition with appropriate example.                                                                                                       | 6 |
| b) Identify the location (or locations) in the code where the race condition occurs.                                                                                                                         | 3 |
| c) Using a semaphore, fix the race condition. It is allowed to modify the <code>decrease_count()</code> function so that the calling process is blocked until sufficient resources are available.            | 8 |
| d) The <code>decrease_count()</code> function returns 0 if sufficient resources are available and -1 otherwise. This leads to awkward programming for a process that wishes to obtain a number of resources: | 8 |

```
while (decrease_count(count) == -1)
 ;
```

Rewrite the resource-manager code segment using a monitor and condition variables so that the `decrease count()` function suspends the process until sufficient resources are available. This will allow a process to invoke `decrease_count()` by simply calling

```
Decrease_count(count);
```

The process will return from this function call only when sufficient resources are available.

6. a) Suppose that a disk drive has 5,000 cylinders, numbered 0 to 4999. The drive is currently serving a request at cylinder 143, and the previous request was at cylinder 125. The queue of pending requests, in FIFO order, is:

86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130

Starting from the current head position, find the total distance (in cylinders) that the disk arm moves to satisfy all the pending requests for each of the following disk-scheduling algorithms.

a) FCFS b) SSTF c) SCAN d) LOOK e) C-SCAN f) C-LOOK

- b) None of the disk-scheduling disciplines, except FCFS, is truly *fair* (starvation may occur).

i. Explain why this assertion is true.

ii. Describe a way to modify algorithms such as SCAN to ensure fairness.

7. a) Here is a table of processes and their associated running times. All of the processes arrive in numerical order at time 0.

| Process ID | CPU Running Time |
|------------|------------------|
| Process 1  | 6                |
| Process 2  | 1                |
| Process 3  | 2                |
| Process 4  | 4                |
| Process 5  | 3                |

- i. Show the scheduling order for these processes under First-In-First-Out (FIFO), Shortest-Job First (SJF), and Round-Robin (RR) scheduling with a time slice quantum = 1 time unit.

- ii. For each process in each schedule above, indicate the queue wait time and turnaround time (TRT).

- b) Assume an operating system is using a scheduling algorithm that gives a higher priority to processes that have used the least CPU time in the recent past.

- i. Why will this algorithm favor I/O-bound processes but not completely starve CPU-bound process?

- ii. Give a formula for priority that would result in a good schedule for this algorithm. Your algorithm should allow a process to move from CPU-bound to I/O-bound and back over longer intervals. Assume you have a function `cpu_usage(int i)` that returns the total CPU usage (up to the current time) of process *i*. Hint: to get the CPU time used in the interval  $(t, t + \Delta)$ , you can call this at time *t*, call it again at  $(t + \Delta)$  and take the difference.

8. a) Explain the steps involved in creating a thread.

- b) How many times does the following program print hello? Justify your answer.

```
#include <stdio.h>
#include <unistd.h>
Main() {
 int i;
 for (i = 0; i < 3; i++)
 fork();
 printf("hello\n");
}
```

- c) Consider a file system that uses inodes to represent files. Disk blocks are 8 KB in size, and a pointer to a disk block requires 4 bytes. This file system has 12 direct disk blocks, as well as single, double, and triple indirect disk blocks. What is the maximum size of a file that can be stored in this file system?

- d) What is the copy-on-write feature, and under what circumstances is it beneficial to use this feature?

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4503: Microprocessors and Assembly Language**

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

**There are 8 (eight) questions. Answer any 6 (six) of them.**

**Figures in the right margin indicate marks.**

1. a) What is machine language? How can we get machine language from an assembly language? Explain with an example. 10  
 b) Briefly explain about multiple interrupt concepts. 8  
 c) What are basic differences between LOOP and LEVEL in assembly language programming? 7
  
  2. a) Derive the contents of the following MOV instructions using its coding template and also show how the contents of the instructions can be stored in memory: 12
    - i. MOV DX, BX
    - ii. MOV AAFFh[DI], AH
    - iii. MOV AX, [1234h]  
 b) Write an assembly language program that will display "Microprocessors and Assembly Language" 10 (ten) times in different lines with line feed and carriage return. 6  
 c) Considering following memory segments, offsets and instructions, write the sequence of PUSH/POP operations on stack segment mentioning different Stack Pointer (SP) values. Assume, initially the stack segment is empty. 7
- | Segment | Offset | Assembly Language |
|---------|--------|-------------------|
| 1000h   | 0100h  | IN AL, 27h        |
| 1000h   | 0102h  | MOV DL, AL        |
| 1000h   | 0104h  | MOV AH, 1         |
| 1000h   | 0106h  | <b>INT 21h</b>    |
| 1000h   | 0108h  | ADD AL, DL        |
- 
3. a) Draw the coding template of IN instruction. Explain the significance of using 'MOD' and 'R/M' in MOV coding template. 9  
 b) Write the equivalent assembly language code structures using *conditional jump* and *loop* instructions to implement the *if-else*, *for* and *while* loop operations. 9  
 c) Suppose, while debugging an assembly language program the values of the registers are: Flag=FEB9h, IP=0102h, CS=0500h, SP=FFFCh. Now, if INT 21h is requested, derive the memory addresses from where the new IP and CS can be retrieved; Also show the new SP value and steps involved in handling the interrupt by the 8086 microprocessor. 7
  
  4. a) Write short differentiations between the following 8086 assembly language instructions: 9
 

|                |                    |                  |
|----------------|--------------------|------------------|
| i. ROL and SHL | ii. LEA and OFFSET | iii. NOT and NEG |
|----------------|--------------------|------------------|

  
 b) Narrate the function of using 1, 2 and 9 under INT 21h instruction. 8  
 c) Distinguish between Memory-mapped I/O and Isolated I/O. 8

5. a) Draw the bus timing diagram for a microprocessor's operation while it performs a WRITE operation toward an OUTPUT unit. 10
- b) What are the basic differences between MIN and MAX mode of 8086 pin diagram? 6
- c) In how many ways can you define an array using assembly language programming? Give example code for each of them. 9
6. a) Draw a comparative table to differentiate between the features of 8086, 80186 and 80286 microprocessors. 10
- b) 'Utilization of parallel processors can be achieved through parallel programming'. How? Prove with appropriate example. 8
- c) Write the functionalities of IOPL and NT flags for 80286 microprocessor. 7
7. a) What do you mean by Coppermine? How do Coppermine and L2 cache memory differ from each other? 8
- b) How are the main memory of 80386 and Pentium processors segmented? Mention the use of address bus pins for both 80386 and Pentium microprocessors. 9
- c) Write an assembly language program, where a MACRO is used to address a string and a PROCEDURE is used to display that string. 8
8. a) Define Thread and Turbo Mode in the context of multi-core processor system? 10
- b) Differentiate between the features of core i3, i5 and i7 processors. 9
- c) Write short notes on:  
 i. U-Pipeline  
 ii. V-Pipeline  
 iii. Floating Point Unit (FPU) 6

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4511: Computer Networks**

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

**There are 8 (eight) questions. Answer any 6 (six) of them.**

**Figures in the right margin indicate marks.**

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 1. a) What is the slot time in CSMA/CD? Explain how the slot time is related to the maximum network length. Explain why a minimum frame size is required for Ethernet.                                                                                                                                                                                                                                                                                                                                                                                                                                  | 3+6+4 |
| b) An Ethernet MAC sublayer receives 3040 bytes of data from the upper layer. Can the data be encapsulated in one frame? If not, how many frames need to be sent? What is the size of the data in each frame?                                                                                                                                                                                                                                                                                                                                                                                           | 4     |
| c) Write short notes on any two of the followings:<br>i. Bluetooth    ii. Go-Back-N ARQ    iii. Network Allocation Vector (NAV)                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 4x2   |
| 2. a) Derive the maximum achievable throughput of a pure ALOHA network. Derive the formula to determine the average transfer delay of a pure ALOHA network.                                                                                                                                                                                                                                                                                                                                                                                                                                             | 4+7   |
| b) What do you mean by vulnerable time? “The vulnerable time in ALOHA depends on the frame transmission time, whereas it depends on the propagation delay in CSMA” - Justify the statement in your own word.                                                                                                                                                                                                                                                                                                                                                                                            | 2+7   |
| c) In CSMA/CA, contention window (CW) changes according to the binary exponential back-off strategy. The initial value of the contention window ( $CW_{min}$ ) is 64. If a station requires 4 transmission attempts to successfully transmit a frame, what would be the back-off counter value for those transmission attempts?                                                                                                                                                                                                                                                                         | 5     |
| 3. a) Name three ICMPv4 query message and three error-reporting messages. Depict the encapsulation process of ICMPv4 error messages. Under what circumstances no ICMPv4 error messages is generated?                                                                                                                                                                                                                                                                                                                                                                                                    | 3+3+3 |
| b) Find the class and default mask of the following IPv4 address. Mention the number of possible IP addresses in each IP class.<br>i. 11000001.00000010.1111110.00000000    ii. 25.23.12.25    iii. 172.32.25.14                                                                                                                                                                                                                                                                                                                                                                                        | 3 × 2 |
| c) A University is granted the address block 18.15.40.0/24, which contains 256 addresses. The university has six departments and needs to divide the addresses into six sub blocks of 128, 64, 32, 16, 8, and 8 addresses. Design the sub blocks and give the slash notation for each sub block that are assigned to different departments. With the aid of a diagram, show the configuration of the University network and answer the following questions:<br>i. What are the valid subnets?<br>ii. What are the broadcast addresses for each subnet?<br>iii. What are the valid hosts in each subnet? | 10    |

4. a) Both IPv4 and IPv6 assume that packet may have different priorities or precedence. Explain how each protocol handles this issue. 6
- b) In an *IPv4* datagram, the M-bit is 0, the value of HLEN is 5, the value of total length is 200, and the fragment offset value is 200. What is the number of the first byte and number of the last byte in this datagram? Is this the last fragment, the first fragment, or a middle fragment? 6
- c) Mention the benefit of dropping the checksum field from IPv6 header. Does it introduce any potential danger of forwarding erroneous packets by IPv6? Explain. 6
- d) Briefly explain the major functionalities of Address Resolution Protocol (ARP) of TCP/IP protocol suite? 7

5. a) Write short notes on any two of the followings: 2 × 4
- i. Longest Mask Matching
  - ii. Address Aggregation
  - iii. Counting to Infinity (C2I)
- b) How does link state routing differ from distance vector routing? Consider the network given in Figure 1. With the indicated link costs, use Dijkstra's shortest-path algorithm used in link state routing to compute the shortest path from **X** to all network nodes. Prepare the routing table for node **X**. 4+6

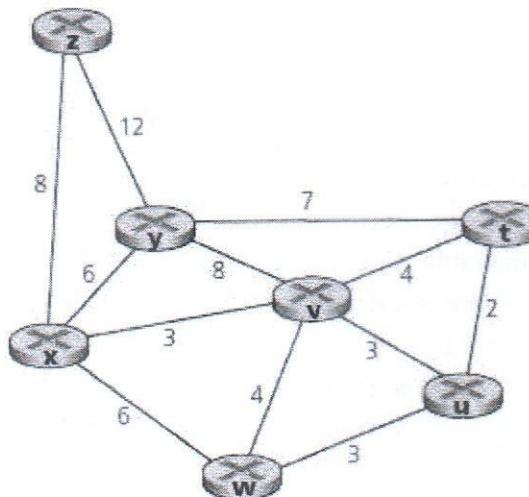


Figure 1: Network for Question 5.b)

- c) What is the C2I (counting to infinity) problem of distance-vector routing? Mention some of the methods to eliminate the problem. 5+2
6. a) A TCP client opens a connection using an initial sequence number (ISN) of 14,534. The TCP server opens the connection with an ISN of 21,732. 4+4
- 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 timeline in y-axis for each side to show the **states** and the relative duration of the client and the server.)
- b) Briefly explain the acknowledgement and retransmission policy of TCP error control mechanism. 6+6
- c) Name different control flags in a TCP segment. Mention the minimum and maximum size of a TCP segment header. 3+2

7. a) How does congestion control differ from flow control in TCP? Suppose you have a TCP source, which starts transmission from segment number 15 with initial value of slow start threshold ( $ssth$ ) 65000. The size of the receiver window ( $rwnd$ ) is always larger than the congestion window ( $cwnd$ ). Draw the timing diagram (time axes toward the bottom of the page for both the source and destination) for the transmission of segments at least up to 25. The diagram should include slow start, congestion avoidance, and one packet loss identified by triple duplicate acknowledgment and one by time out. 3+10
- b) Briefly explain the significance of Persistence timer and TIME-WAIT timer in TCP? A host sends five packets and receives three acknowledgments. The time is shown as hour:minute:seconds. 6+6
- i. Segment 1 was sent at 0:0:00.
  - ii. Segment 2 was sent at 0:0:05.
  - iii. ACK for segments 1 and 2 received at 0:0:07.
  - iv. Segment 3 was sent at 0:0:20.
  - v. Segment 4 was sent at 0:0:22.
  - vi. Segment 5 was sent at 0:0:27.
  - vii. ACK for segments 3 and 4 received at 0:0:45.
  - viii. ACK for segment 5 received at 0:0:65.
- Calculate the values of  $RTT_M$ ,  $RTT_S$ ,  $RTT_D$ , and RTO of the retransmission timer of TCP. Given that the original RTO is 6 seconds.
8. a) Mention the major security goals of a computer network. How does symmetric key cryptography differ from asymmetric key cryptography? 2+4
- b) How do the classical ciphers differ from the modern ciphers? Encrypt the message "successful" using the Playfair cipher using the key "*Crypto*". 4+4
- c) Organizations with strict security often enforce password policies in order to make password management more secure. What could such policies be? Give examples. Discuss in what ways strict password policies may actually make password management less secure. 6
- d) Write a short note on any one of the followings: 5
- i. Replay Attack
  - ii. Reflection Attack

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**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.**

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

1. a) What is the relationship among error, fault and failure? How can software defects be prevented in the early stage of the software development? 2+3
- b) "Consider a hospital management website used by hospital staffs, doctors and patients for making appointments. The system also provides suggestions regarding nearby hospitals, consultancy centers, diagnostic centers etc. The system stores data in both cloud and file storage system." Given the scenario, draw the Architectural Context Diagram of the system. 5
- c) Assume, IUT course management system enables the course manager, teachers and students manage courses during a semester. At the beginning of each semester, the course manager creates the list of offered courses. It is the task of the course manager to create, delete or update course information. Teachers are also assigned courses by the manager. Each course is coordinated by a teacher. Students can enroll in multiple courses during a semester through the system. 2+4+4  
 Given the scenario, answer the followings:  
 i. Identify the data entities of the system.  
 ii. Draw the Entity Relationship Diagram of the scenario  
 iii. Draw the Schema Diagram of the scenario.
- d) Identify and explain the Generalization, Aggregation and Composition relationships in the following Figure 1. 5

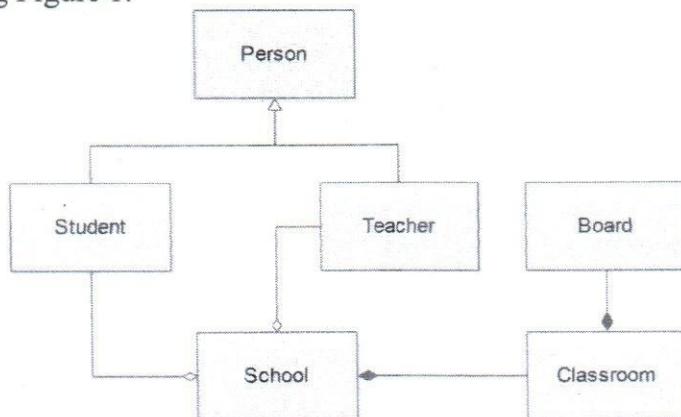


Figure 1: ERD for Question 1(d)

2. a) Describe Cross Site Scripting (XSS) with example. How can this attack can be prevented in web based systems? 3+3
- b) Capability Maturity Model (CMM) is a framework to analyze the approach and techniques followed by any organization to develop a software product. Briefly describe the organizational characteristics based on which CMM model analyzes the standard of an organization. 6
- c) What is Six Sigma? How is it used to assure industry level software quality? 5
- d) Define and draw Waterfall and Agile Software Process model. Discuss the advantages and disadvantages of each model. 4+4

3. a) Define Test Coverage. "100% coverage does not mean 100% tested." – Explain the assertion. 2+3
- b) What is Cyclomatic Complexity? Given the code listing in Figure 2, compute the cyclomatic complexity, and identify the basic path set that can cover all the branches of the program. 1+7+6

```

int perform (int[] numbers, int N) {
 int i, count, sum, mean;
 i=count=sum=0;

 while (i<N && numbers[i]!=-1) {
 if (numbers[i]>=0 && numbers[i]<=1000) {
 count+= 1;
 sum+= numbers[i];
 }
 i+= 1;
 }
 if (count>0 && sum>0)
 mean = sum/count;
 else
 mean = -1;
 return mean;
}

```

Figure 2: Code listing for Question 3(b)

- c) Quality Engineering process has three activities – Pre-QA, In-QA and Post-QA activities. Briefly describe and draw the overall Quality Engineering Process. 3+3
4. a) State the differences between Black Box and White Box Testing. Following are fields that a user fills out while registering to a system: 2+12
- Username:** must be between 6 and 12 characters long, must start with a letter and include only letters and digits.
- Age:** must be a number greater or equal to 18 and less than 65.
- City:** must be one of Dhaka, Chittagong, Khulna or Sylhet
- Postalcode:** must be 6 characters long, start with a letter and alternates between letters and digits.
- List valid and invalid equivalence classes for each input fields with examples.
  - Besides for each field identify the boundary values.
- b) Consider, in a website a user is prompted to upload a profile picture with certain conditions like – the image should be in '.jpg' format, the file size should be less than 32kb and the resolution should be exact  $157 \times 177$ . If any of the conditions fails the system will throw corresponding error message stating the issue and if all conditions are met photo will be updated successfully. 5
- Draw the decision table for testing all possible situations a user can face while uploading the profile picture.
- c) What are Quality Control (QC), Quality Assurance (QA) and Total Quality Management (TQM)? How can you advance your organization from QC to TQM? 3+3
5. a) Design patterns are known solution to existing problems. Abstract Factory pattern is applicable where multiple families of object components are involved while object creation. Demonstrate the Abstract Factory pattern with an example code. 10
- b) Explain the quotation – "Don't unit-test GUIs. It's more trouble than it's worth." If so, how can we test GUI code? 2+1

- c) XYZ company has completed the development of a website for Education Board Result Management System. Before releasing the product online, they have to perform rigorous testing. The company have decided to test following scenarios before product release:

- i. At any particular time, generally 1000 users hit the website simultaneously. The system should behave normally, if concurrently 1000 users search for the results.
- ii. During result publication hours, huge number of users may hit the system. If more than 1000 users query for result concurrently, the system may behave abnormally. After such a case, the system should resume properly with no data lose.
- iii. Hackers may try to corrupt the system by sending 10,000 requests at a second.
- iv. After result publication, most users tend to generate and download result reports.

For each of the above test scenarios identify and justify which testing type needs to be applied.

- d) Is there any code smell in the following code snippet of Figure 3? If yes, describe methods to remove this smell. 4

---

```
public class Report{
 void printReport(Profile profile) {
 string name = profile.GetFirstName() + " " +
 profile.GetLastName();
 System.out.println("Name is: "+name);
 string department = profile.GetDepartmentName();
 System.out.println("Department is: "+ department);
 double salary = profile.getBaseSalary() +
 profile.getBaseSalary() *.30;
 double tax = salary * .05;
 System.out.println("Salary is: "+salary+"and Tax is:"+tax);
 }
}
```

---

Figure 3: Code listing for Question 5(d)

- |    |                                                                                                                                                                                                                                                                                                                                                                                       |     |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 6. | a) How is SQL Injection carried out to attack web systems? What precaution needs to be taken to prevent it?                                                                                                                                                                                                                                                                           | 3+2 |
| b) | What is Refactoring? What are the two advices we need to follow before refactoring?                                                                                                                                                                                                                                                                                                   | 2   |
| c) | What is the difference between Stub and Driver? Describe with example. Write a code sample where Mock testing is used.                                                                                                                                                                                                                                                                | 4+4 |
| d) | Observer Pattern defines a one-to-many dependency between objects so that when one object changes state, all its dependents are notified and updated automatically. Briefly describe observer pattern with an example.                                                                                                                                                                | 10  |
| 7. | a) State the difference between Singleton and Flyweight pattern.                                                                                                                                                                                                                                                                                                                      | 3   |
| b) | What is Unit Testing? Do we write unit tests for all methods of code repository, Why?                                                                                                                                                                                                                                                                                                 | 2+2 |
| c) | Developers are always sensitive about their written code. A developer has written a calculator class that can calculate the average of array of integers. However, with time the requirement changes and now, the client wants to calculate the average of list of integers. Explain how the developer can adapt with the new requirement by applying the appropriate design pattern. | 7   |
| d) | What is Long Method smell? Describe three mechanisms for reducing this code smell.                                                                                                                                                                                                                                                                                                    | 1+6 |
| e) | Briefly Explain Refused Bequest. Which design pattern can provide the solution for refused bequest and How?                                                                                                                                                                                                                                                                           | 4   |

8. a) Explain the terms – Test Driven Development (TDD), Sanity Testing, Scalability, Lazy Instance. 8
- b) Define Oddball Solution with example. State the difference between literal and semantic code duplication. 2+2
- c) Managers, Postman, Firefighters and Computer Engineers all are workers. All of them generally follow a similar daily routine like get up from sleep, get food, go for work, do work, return home, relax and get sleep. However, their way of working and relaxing will be different based on their job types. Having this scenario, apply and demonstrate Template Pattern such that code duplicity can be reduced. 7
- d) Identify the code smells from the following code snippet in Figure 4: 6

```

Public void Course{

 string courseName;
 int id;

 public Course(String name, int id) {
 this.courseName = name;
 this.id = id;
 }
 List<Student> students = new ArrayList<Student>();

 void EnrollStudent(string name, int id, string date, string department, string city, string country, string birthdate){
 students.add(new Student(name, id, city, "", "000000", department, date, country, birthdate));
 }
 void findStudentByDepartment(string dept) {
 foreach(Student s: students){
 if(s.department.Equals(dept)){
 System.out.println(s.id);
 }
 }
 }
 void findStudentByCity(string city) {
 for(int i=0; i< students.size(); i++){
 if(students.get(i).city == city){
 System.out.println(s.id);
 }
 }
 }
}

```

Figure 4: Code listing for Question 8(d)

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4531: E-Commerce and Internet Security**

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

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

- |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |    |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 1. | a) You have been given the key as: <b>NOIICE</b> . Draw the Play-Fair table.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 3  |
| b) | Decrypt the following text using the play-fair table in 1(a).<br><b>"JTIUYSIZNOAKOUZFSG"</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 10 |
| c) | Decipher the following text using Row Transposition cipher. The key is: <b>3251674</b><br><b>"SBANHODDTOTOYUGMTXIDEEIYRTSESS"</b><br>Why is this row transposition cipher weak? How to improve it? Show the improved ciphertext.                                                                                                                                                                                                                                                                                                                                                    | 12 |
| 2. | a) Mr. Ahlan wants to market "IUTbuynsell.com" using search engine marketing but it has created some issues. What are they? Describe in brief.                                                                                                                                                                                                                                                                                                                                                                                                                                      | 10 |
| b) | Elon Flusk is an avid reader. He is subscribed to Amazon Books. Every time Flusk logs in to Amazon app, the app greets him with a personal message. Last month he just finished reading "Da vinci code" by Dan Brown. Today he logged into amazon and saw "Angels & Demons" by the same writer in the recommended section. He was quite fascinated by this.<br>What E-Marketing strategy did Amazon Books used? How is it effective? Describe the strategy in brief.                                                                                                                | 7  |
| c) | What do you understand by the term " <i>Social Graph</i> " in Search Engine Marketing?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 3  |
| d) | Differentiate between "Cookies" and "Bugs".                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 5  |
| 3. | a) "IUTbuynsell.com" is a platform where users can buy and sell products, much like eBay. Some of the various functionalities include user login, browse categories, dynamic cost calculation, sorting according to price, add to cart, view cart etc. For different functionalities, different databases are maintained.<br>To build a full-scale website like this, which architecture should one use? Draw the architecture modules with the functionalities mentioned in the passage and briefly explain them.                                                                  | 10 |
| b) | " <b>Perallox</b> " is an up and coming small burger place in Uttara that specializes in both chicken and beef burgers. They also provide take-away and home delivery options. They have good chefs who can make unique burger patties containing herbs from Latvia, a cuisine which the Bangladeshi people is very unfamiliar to. But knowing the revolution of burger industries in Bangladesh, Perallox is probably going to face a lot of difficulties in making profit with competitors such as Takeout, Madchef, Chillox etc.<br>Perform a <b>SWOT</b> analysis for Perallox. | 11 |
| c) | How do "Metatags" optimize websites?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 4  |

4. a) Consider the following website below:

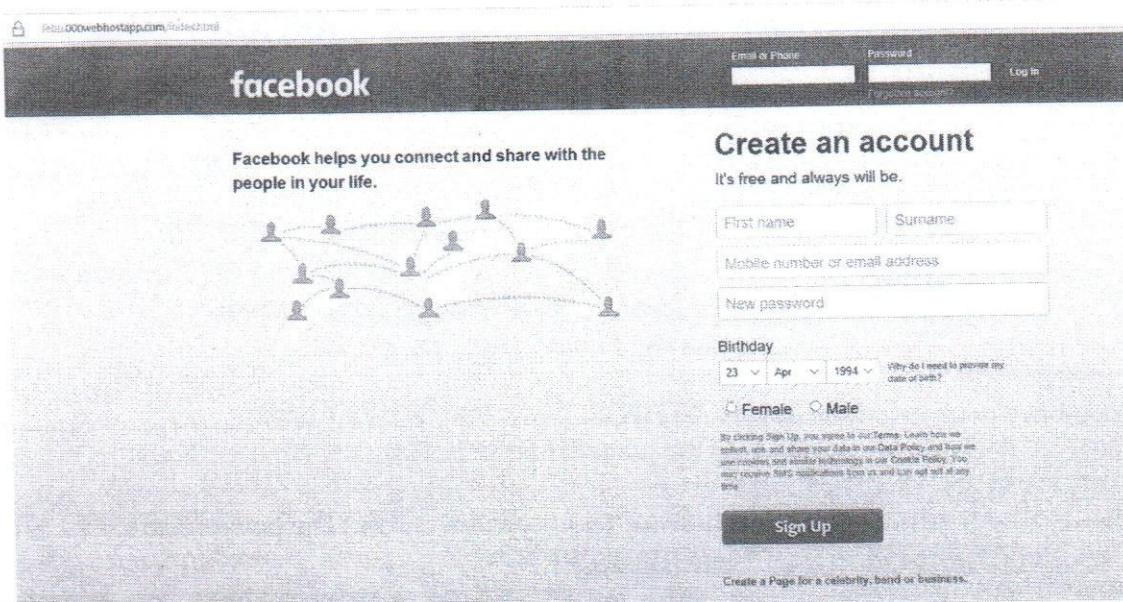


Figure 1: Figure for the question no. 4 (a)

Which type of footprinting methodology is performed here? Explain how it is performed in hacking.

- b) Using Google Hacking technique you came across an “.xls” file that contains records like the following structure:

|                          |               |
|--------------------------|---------------|
| Talharocks63@hotmail.com | doireallyrock |
| Ecompera@oic-dhaka.edu   | mathisk3wL    |
| Ahmed.karim63            | wifename1995  |

What is google hacking? How did you perform it? Show the search queries. What can you do with this file?

- c) Differentiate between “Shoulder surfing” and “Dumpster diving”.  
d) Briefly explain “traceroute”.

5. a) Consider the following scenario below:

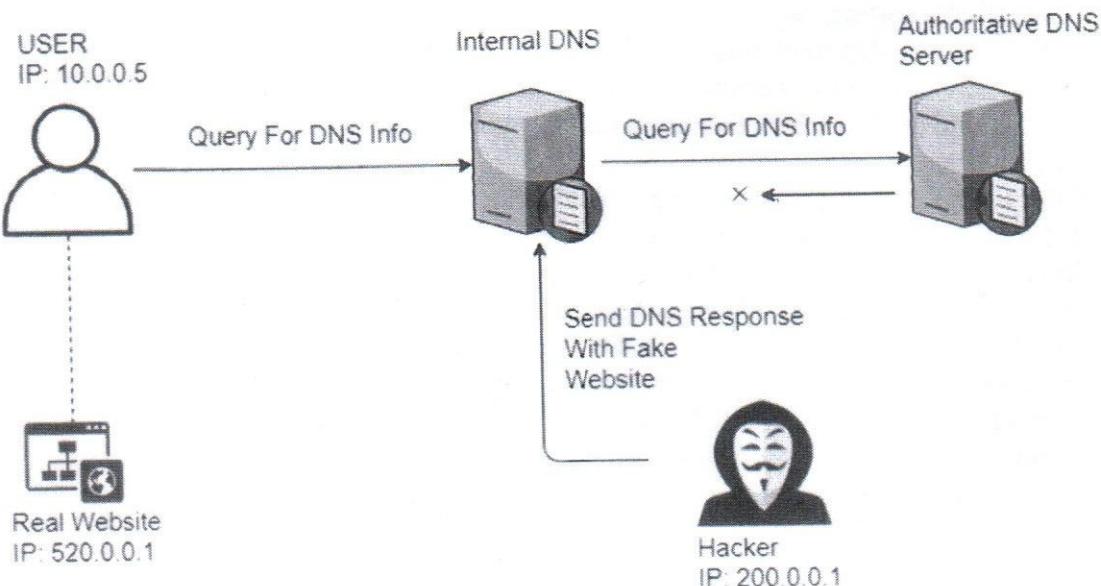


Figure 2: Figure for the question no. 5 (a)

In figure 2, Mark Iceberg (IP: 200.0.0.1), a professional hacker wants to hack User 10.0.0.5 and get his credentials. He has created a fake version of the original website with the IP: 420.0.0.1. He has somehow managed to intercept the query response from the authoritative DNS server. The internal DNS computer is running a program called *CCleaner*, which cleans the cache of any system. Now the hacker has sent a fake DNS response to the internal DNS.

Will this method work? If yes, show the detailed procedure with diagram. If the answer is no, how can Iceberg hack User? Show with diagrams.

- |                                                                               |   |
|-------------------------------------------------------------------------------|---|
| b) Why does the attacker need to fill the CAM table of the adjacent switches? | 5 |
| c) Differentiate between ARP Spoofing and MAC Spoofing.                       | 6 |
| d) What is <i>promiscuous mode</i> ?                                          | 4 |
6. a) Consider the following figure below:

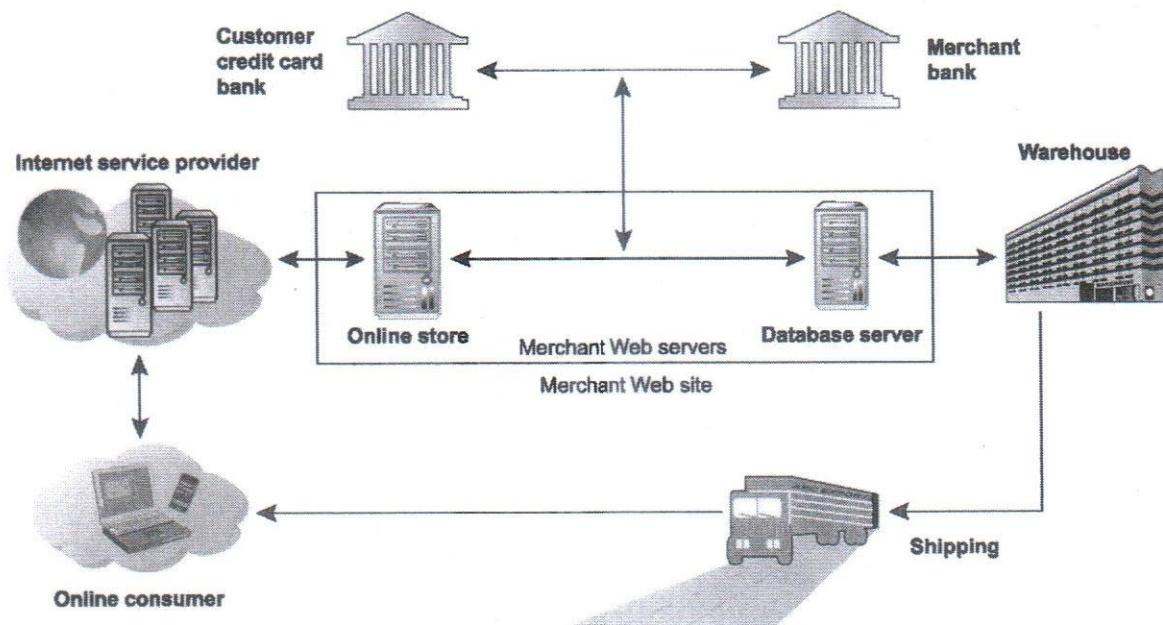


Figure 3: Figure for the question no. 6 (a)

Draw the same diagram and identify and write the vulnerable points in this E-Commerce transaction.

- |                                                                                                                                                                                                                                                                                           |    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| b) Mark Iceberg wants to send a secret file to his friend. He is currently using Public Key encryption but he is facing problems. He wants to use an advanced mechanism. What kind of problems is he facing? Draw and explain the improved public key encryption mechanism using diagram. | 10 |
| c) After encrypting the file, Iceberg wants to send it. He notices that the browser link starts with " <i>http://</i> " so he becomes worried. He wants to secure the communication channel. How can he secure the channel? Explain.                                                      | 6  |
| d) What do you mean by " <i>float</i> " in E-Payment systems?                                                                                                                                                                                                                             | 3  |

7. a) Mark Iceberg, a skilled hacker has crafted the following malicious link: 9  
 "<A HREF=*http://bank.com/registration.cgi?clientprofile=<SCRIPT>malicious code</SCRIPT>Click Here</A>*"
- What is XSS attack and how can Iceberg perform XSS via email using the link? Describe using diagrams.
- |                                                                         |   |
|-------------------------------------------------------------------------|---|
| b) Differentiate between "Password List" and "Password Dictionary".     | 4 |
| c) How does <b>Session ID Prediction</b> work? Explain with an example. | 6 |

- d) Consider the following code snippet:  
"Data source=Server, Port; Network Library=DBMSSOCN; Initial Catalog=DataBase;  
User ID=talharocks; Password=pwd;"  
Which type of Web App Hacking methodology will you perform using this type of code  
and how will you do it?

8. a) Write short notes on the following:

3×  
5

- i) Ransomware
- ii) Vishing
- iii) DoS Vs DDoS
- iv) Acceptance Testing
- v) Virtual Currencies

b) How to detect sniffer using the ARP method?

5

c) What are the key factors of choosing an E-Commerce Suite?

5

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4539: Web Programming**

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

**There are 8 (eight) questions. Answer any 6 (six) of them.**

**Figures in the right margin indicate marks.**

1. a) Write the necessary HTML codes for creating the following page. (Give proper names to each input fields so that they can be later accessed easily for validation.) 10

The form is titled "Create an account" and features a sub-headline "It's free and always will be." It contains several input fields: "First name" and "Last Name" in separate boxes, "Your Email" and "Re-enter Email" in a single combined box, and "New password". Below these are "Birthday" fields with dropdown menus for "Day", "Month", and "Year", and a link "Why do I need to provide my Birth Date?". At the bottom, there are gender options "Female" and "Male" with radio buttons, and a link "By clicking Sign Up, you agree to our Terms, Data Policy and Cookie Policy. You may receive SMS notifications from us and can opt out at any time." A large "Sign Up" button is at the very bottom.

Figure 1: Sign up page for question 1. a)

- b) Consider the webpage created in Question 1(a). Now using JavaScript, show an alert message in 10 each of the following cases:
- i. If the user forgets to put value for any of the fields.
  - ii. If the user enters an invalid password. The password not only be consists of numbers, but also characters from A-Z or a-z. The password can be minimum 8 and maximum 20 characters long.
  - iii. If the entered Email does not match in both cases.
- c) How can the *meta* tag in HTML be used to enhanced Search Engine Optimization in web development? 5

2. a) What is SESSION? Explain how session works. 6
- b) Assume that you are asked to develop a website that consist of only two webpages, the login and the view result webpage. The requirements for the website are: 16
- The login page to validate a user by using the fields of studentId and password for login.
  - The view result webpage should show his/her results from the database and a log out button.
  - If a user is logged in, only then he can see his results.
  - If a user who did not log in, tries to access the view result webpage, he should be redirected back to the login page.
- (Hint: Maintain the user session)
- c) Compare between client-side scripts and server-side scripts. 3

3. a) What are the different error levels in PHP and how can those errors be handled? 6

A mysql database has a table named “Customers”, its schema is given below

*Customers (name, date\_of\_birth, address, country, password)*

Database Authentication information:

Database server: localhost

Database name: webstore

Database user: admin\_user

Database user password: D2te#7

- b) Write a PHP script to display a sorted list of Customers in a tabular format. The list should be sorted by in descending order of customers' name. Each row of the table shows customer's name, address, country. 6
- c) What is the significance and benefits of including 'use strict' at the beginning of a JavaScript source file?

4. a) A webpage takes three numbers as input from the user via three textboxes. On pressing a button, it returns the product of the first two numbers added to the third. Figure 2 below shows an example. 15

Write the HTML and JavaScript code required to develop such functionality.

The figure consists of two side-by-side screenshots of a web browser window. Both screenshots show a 'Document' tab at the top. Below the tab, there is a search bar with the placeholder 'Search Google or type a URL'. Underneath the search bar, there are three empty text input fields stacked vertically. Below these input fields is a blue 'Calculate' button. In the bottom right corner of the browser window, there is a text area labeled 'Result =' followed by a blank space. The left screenshot shows this entire setup. The right screenshot shows the same setup but with the first input field containing the number '3', the second input field containing '4', and the third input field containing '5'. To the right of the third input field, the text area labeled 'Result =' now contains the value '17'.

Figure 2: example for question 4.a)

- b) Differentiate between Responsive and Adaptive Web sites. 5
- c) Compare between fixed and flexible web page design strategies. 5

5. a) What is Responsive Web Design? What are its advantages? 5  
 b) Write short notes on the CSS property *transform* and its different possible values. 5  
 c) Write the HTML code to generate the web page given in Figure 3 below. 15

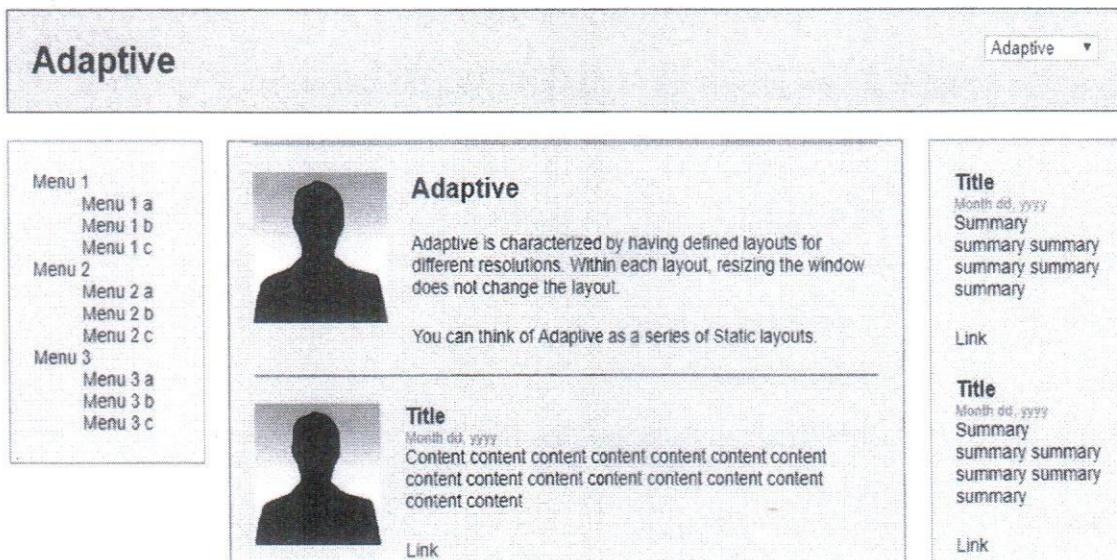


Figure 3:

## Instructions:

- The name of the image is 'avatar.jpg'
- Make proper use of margins, padding and borders if necessary.
- The left section (Menu 1, Menu 2 and Menu 3) is a definition list and each of the elements is containing links.

6. a) What are COOKIES? Explain how cookies work. Give practical examples of how cookies can be created, edited, and deleted. 10  
 b) What are super global variables in PHP? Give practical examples and how they are used. 6  
 c) A business site has 12 web pages. Business owner wants to show a message for each visitor at the top-right corner of the website. That message should contain visitor's IP address, and arrival date and time of current session. How can you do that for the businessman? 9
7. a) What are the differences between GET method and POST method in PHP? Explain where to use and where not to use each one of these methods with examples. 10  
 b) Given the following unordered list, 6
  - [Home](#)
  - [About](#)
  - [Services](#)
  - [Contact](#)

Write CSS code required to transform the above list into a navigation bar list as follows, Assume the normal tags where used to create the list



- c) What is Name Space in a DNS system? 4
- d) With examples write the differences between `document.querySelector()` and `document.querySelectorAll()`? Give an example 5
8. a) What is AJAX? What are the advantages of AJAX to web programmers? 4
- b) Assume that you have the following To-do list webpage. 21

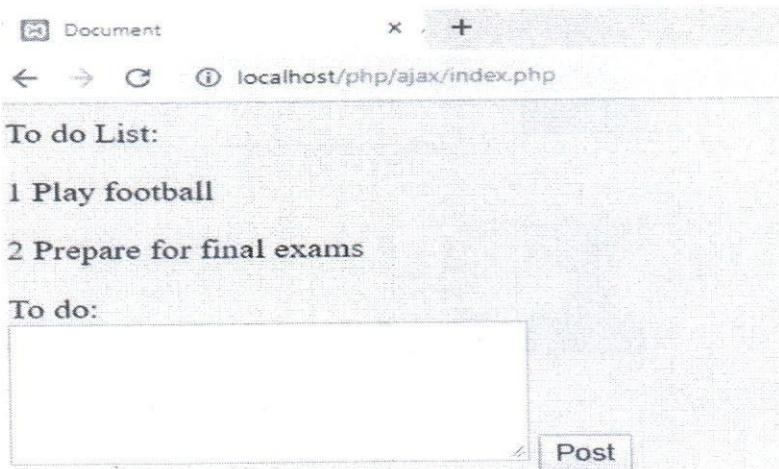


Figure 4:

- i. Write a PHP file, `ajax_to_do.php`, to generate the above page and also uses AJAX to send a POST request to a PHP file named `post_to_do.php`.
- ii. The PHP file, `post_to_do.php`, should connect and store the newly added to-do item into the database and return true if successful or false otherwise.
- iii. Write a JavaScript function named `updateTodo()` that will use the DOM to add the new item to the already existing ordered list.

(Note: You can assume all database connectivity information)

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

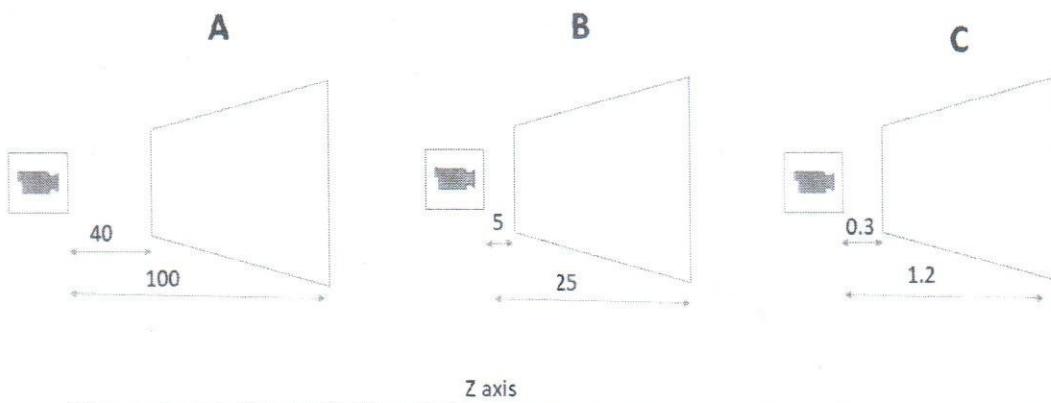
**CSE 4551: Computer Graphics and Multimedia Systems**

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

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

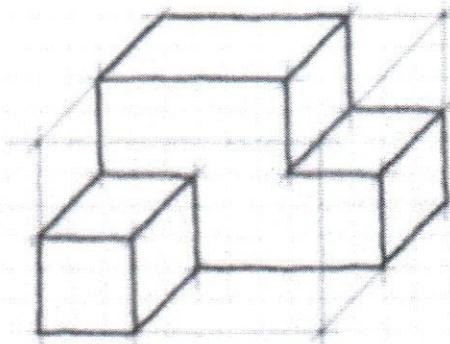
- |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |    |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 1  | a) Given an <b>up</b> vector (2,3,1) and a <b>look</b> vector (1,2,1), construct a 3D co-ordinate system (u,v,w) based on these camera-specification vectors.                                                                                                                                                                                                                                                                                                                                                                                                                                    | 10 |
| b) | Consider the co-ordinate system from part (a). Consider also, that for an arbitrary perspective view volume, we have set the far plane at depth 5. Consider a width angle of 64 degrees and an aspect ratio of 16:9 (width:height). Lastly, consider a center of projection <b>P</b> (100,150,100). Firstly, deduce the height angle. Then, given this information, write down the correct <b>sequence</b> of translation, rotation, and scaling matrices to transform this arbitrary perspective frustum to the canonical perspective frustum. There is no need to calculate the final product. | 8  |
| c) | Consider the information from parts (a) and (b). Consider also that for the arbitrary frustum the near plane was at depth 2. Write down the unhinging transform that takes our perspective frustum and turns it into a parallel view volume.                                                                                                                                                                                                                                                                                                                                                     | 3  |
| d) | Prove, using vigorous demonstration and with values of your choice, that an unhinging transform matrix works.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 4  |
| 2  | a) What is the basic idea behind the Painter's algorithm? Mention its primary limitation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 4  |
| b) | Explain backface culling with the aid of a diagram. What condition must hold for backface culling to be effective?                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 5  |
| c) | Demonstrate the idea behind the z-buffer algorithm with the aid of an example. Discuss advantages and limitations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 12 |
| d) | What is Z-Fighting? Given the following perspective frustums, rank the scenarios according to the severity of z-fighting they are likely to experience. Explain why. (Figures are not drawn to scale, so please avoid purely visual assessment. A, B, and C are independent setups with no connection to each other.)                                                                                                                                                                                                                                                                            | 4  |



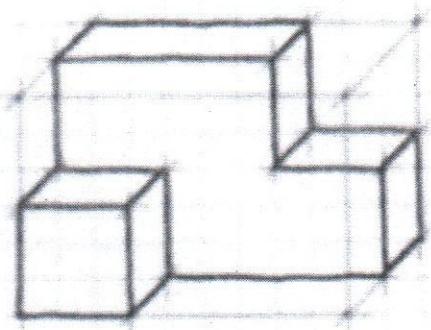
**Figure 1:** Three different perspective frustum setups – A, B and C.

- 3 a) Name the two main types of oblique projections. Now, match the following images to the correct type of oblique projection. Provide reasoning. 5

A

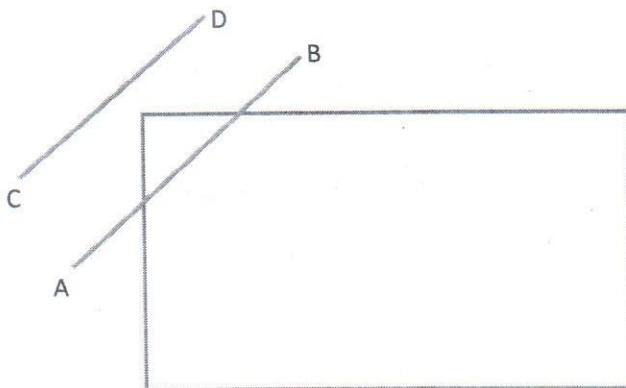


B



**Figure 2:** The same scene projected obliquely in two different ways.

- b) Explain perspective foreshortening with the aid of an example. What are vanishing points? In the case where the face-normals of the object being projected are perpendicular to the coordinate axes, what is an easy way to estimate the number of vanishing points for the resulting image? 8
- c) What are view volumes? Why do we often prefer parallel view volumes over perspective frustums? 5
- d) Justify the necessity for both near and far clipping planes. How do the up and look vectors of a synthetic camera help to define the scene? What is the single constraint that up and look vectors must satisfy, with respect to each other? 7
- 4 a) Derive the expression for the value of  $t$ , the parametric intersection point between the line and the clipping window, in the Cyrus Beck Line Clipping Algorithm. Figures are not necessary. 5
- b) A clipping window has co-ordinates: A(10,20), B(30,20), C(30,10) and D (10,10). A line has endpoints P(8,9) and Q(31,33). Find the final pair of  $t_{\text{entering}}$  and  $t_{\text{leaving}}$  values for this problem, using the Cyrus Beck line clipping algorithm. Using these values, find the final clipping points for the line. 10
- c) Show how the Cohen Sutherland line clipping algorithm distinguishes between the fact that line AB should be partially clipped and that line CD should be completely removed. 5



**Figure 3:** A clipping window and two lines, AB and CD.

- d) One of the exit conditions for the Cyrus Beck Algorithm is when a  $t_{leaving}$  value is found to be lower than its corresponding  $t_{entering}$  value. Show an example scenario where this applies with the aid of a diagram. Using the directions of the vectors and normals, along with the sign of the dot-product check condition, show that when a t-leaving value is indeed generated **before** a t-entering value, that line should be discarded. Exact calculations and co-ordinates are **not** needed.
5. a) Derive, from the very beginning, the expressions for the values of  $d_{start}$ ,  $\Delta E$ , and  $\Delta SE$  during the scan conversion of a **circle**. Remember to also use second differences to show how  $\Delta E$  and  $\Delta SE$  can be updated efficiently. 10
- b) Scan convert a circle, centered at the origin, and of radius 10 units. Show only the first five points, starting from the y axis. 8
- c) Distinguish between the radial distance decision and the vertical distance decision. The full derivation is **not** necessary. 3
- d) What adjustment needs to be made for scan converting ellipses? Show how this is done mathematically. 4
6. a) What is a cumulative transformation matrix? Illustrate with an example. 6
- b) Based on your learning in this course, provide one specific use-case for the dot product and one for the cross product. 6
- c) Suppose you want to rotate an object about any arbitrary point in 2D. Assume that this arbitrary point has co-ordinate  $(X_p, Y_p)$ . Assume also that the rotation angle is  $\phi$  degrees in the **clockwise** direction. Find a single, final matrix that does this, when it is multiplied to the object's co-ordinates. 6
- d) Transformation matrices for almost all transforms can be derived by locating where the unit vectors in the x and y directions are transformed to. As an example, a reflection in the x axis leaves the x-unit vector, which is  $(1,0)$ , intact, but transforms the y unit vector from  $(0,1)$  to  $(0,-1)$ . The transformation matrix then becomes  $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$ , with the first and second columns representing where the x and y vectors are transformed to, respectively. 7
- Now, **U** is a  $2 \times 2$  matrix representing a 90-degree anticlockwise rotation around the origin  $(0,0)$ . **V** is a  $2 \times 2$  matrix representing a reflection in the line  $y = -x$ . The composite matrix **R** is the product of **V** and **U** ( $R = VU$ ). This new matrix **R** can also be considered as one single geometric transformation. Find **R**, and state the **single** geometric transform that it represents.
7. a) What are splines? Provide a brief discussion on the two main types of splines discussed in this course. 5
- b) How is a triangle mesh representation of objects stored in the computer? In this representation, what is a simple way of differentiating between front and back faces? 5
- c) Discuss geometry-based graphics and sample-based graphics in detail. What are some of the benefits and limitations of a sample-based system? 10
- d) Differentiate between vector display hardware and raster displays. What is the main limitation when displaying an image through a raster display? 5

8. a) Explain how the **perspective** normalizing transform derives its
- i) Rotation Matrix 10
  - ii) Scaling Matrix
- b) What kind of parallel projection retains only a single face of the object being projected, after projection? Provide evidence as to how and why. 5
- c) During Visible Surface Determination, we know the depth information only at the vertex locations. How do we efficiently fill in the “in-between” z buffer information? 5
- d) For perspective transformations, one of the major issues is that points converge towards the far clipping plane (z-compression). This makes interpolating pixel properties, such as color, difficult. How do we solve this issue? 5

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4573: Microprocessors and Assembly Language Programming**

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

**There are 8 (eight) questions. Answer any 6 (six) of them.**

**Figures in the right margin indicate marks.**

1. a) What is machine language? How can we get machine language from an assembly language? Explain with an example. 10
  - b) Briefly explain about multiple interrupt concepts. 8
  - c) What are basic differences between LOOP and LEVEL in assembly language programming? 7
  
  2. a) Derive the contents of the following MOV instructions using its coding template and show how the contents of the instructions can be stored in memory: 12
    - i. MOV DX, BX
    - ii. MOV AAFFh[DI], AH
    - iii. MOV AX, [1234h]
  - b) Write an assembly language program that will display "Microprocessors and Assembly Language" 10 (ten) times in different lines with line feed and carriage return. 6
  - c) Considering following memory segments, offsets and instructions, write the sequence of PUSH/POP operations on stack segment mentioning different Stack Pointer (SP) values. Assume, initially the stack segment is empty. 7
- | Segment | Offset | Assembly Language |
|---------|--------|-------------------|
| 1000h   | 0100h  | IN AL, 27h        |
| 1000h   | 0102h  | MOV DL, AL        |
| 1000h   | 0104h  | MOV AH, 1         |
| 1000h   | 0106h  | INT 21h           |
| 1000h   | 0108h  | ADD AL, DL        |
- 
3. a) Draw the coding template of IN instruction. Explain the significance of using 'MOD' and 'R/M' in MOV coding template. 9
  - b) Write the equivalent assembly language code structures using *conditional jump* and *loop* instructions to implement the *if-else, for* and *while* loop operations. 9
  - c) Suppose, while debugging an assembly language program the values of the registers are: Flag=FEB9h, IP=0102h, CS=0500h, SP=FFFCh. Now, if INT 21h is requested, derive the memory addresses from where the new IP and CS can be retrieved; Also show the new SP value and steps involved in handling the interrupt by the 8086 microprocessor. 7
  
  4. a) Write short differentiations between the following 8086 assembly language instructions: 9
 

|                |                    |                  |
|----------------|--------------------|------------------|
| i. ROL and SHL | ii. LEA and OFFSET | iii. NOT and NEG |
|----------------|--------------------|------------------|
  - b) Narrate the function of using 1, 2 and 9 under INT 21h instruction. 8
  - c) Distinguish between Memory-mapped I/O and Isolated I/O. 8

5. a) Draw the bus timing diagram for a microprocessor's operation while it performs a WRITE operation toward an OUTPUT unit. 10
- b) What are the basic differences between MIN and MAX mode of 8086 pin diagram? 6
- c) In how many ways can you define an array using assembly language programming? Give example code for each of them. 9
6. a) Draw a comparative table to differentiate between the features of 8086, 80186 and 80286 microprocessors. 10
- b) 'Utilization of parallel processors can be achieved through parallel programming'. How? Prove with appropriate example. 8
- c) Write the functionalities of IOPL and NT flags for 80286 microprocessor. 7
7. a) What do you mean by Coppermine? How do Coppermine and L2 cache memory differ from each other? 8
- b) How are the main memory of 80386 and Pentium processors segmented? Mention the use of address bus pins for both 80386 and Pentium microprocessors. 9
- c) Write an assembly language program, where a MACRO is used to address a string and a PROCEDURE is used to display that string. 8
8. a) Define Thread and Turbo Mode in the context of multi-core processor system? 10
- b) Differentiate between the features of core i3, i5 and i7 processors. 9
- c) Write short notes on:  
 i. U-Pipeline  
 ii. V-Pipeline  
 iii. Floating Point Unit (FPU) 6

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4581: Web Programming**

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

**There are 8 (eight) questions. Answer any 6 (six) of them.**

**Figures in the right margin indicate marks.**

1. a) Write the necessary HTML codes for creating the following page. (Give proper names to each input fields so that they can be later accessed easily for validation.) 10

The form is titled "Create an account" and contains the following fields:

- First name
- Last Name
- Your Email
- Re-enter Email
- New password
- Birthday (Day, Month, Year dropdowns)
- Gender selection (Female, Male radio buttons)
- A note: "By clicking Sign Up, you agree to our Terms, Data Policy and Cookie Policy. You may receive SMS notifications from us and can opt out at any time."
- A "Sign Up" button at the bottom.

Figure 1: Sign up page for question 1. a)

- b) Consider the webpage created in Question 1(a). Now using JavaScript, show an alert message in each of the following cases: 10
- i. If the user forgets to put value for any of the fields.
  - ii. If the user enters an invalid password. The password not only be consists of numbers, but also characters from A-Z or a-z. The password can be minimum 8 and maximum 20 characters long.
  - iii. If the entered Email does not match in both cases.
- c) How can the *meta* tag in HTML be used to enhanced Search Engine Optimization in web development? 5

2. a) What is SESSION? Explain how session works. 6
- b) Assume that you are asked to develop a website that consist of only two webpages, the login and the view result webpage. The requirements for the website are: 16
- The login page to validate a user by using the fields of studentId and password for login.
  - The view result webpage should show his/her results from the database and a log out button.
  - If a user is logged in, only then he can see his results.
  - If a user who did not log in, tries to access the view result webpage, he should be redirected back to the login page.
- (Hint: Maintain the user session)
- c) Compare between client-side scripts and server-side scripts. 3

3. a) What are the different error levels in PHP and how can those errors be handled? 6
- A mysql database has a table named “Customers”, its schema is given below 13
- Customers (name, date\_of\_birth, address, country, password)*

Database Authentication information:

Database server: localhost

Database name: webstore

Database user: admin\_user

Database user password: D2te#7

- b) Write a PHP script to display a sorted list of Customers in a tabular format. The list should be sorted by in descending order of customers' name. Each row of the table shows customer's name, address, country. 6
- c) What is the significance and benefits of including 'use strict' at the beginning of a JavaScript source file?

4. a) A webpage takes three numbers as input from the user via three textboxes. On pressing a button, it returns the product of the first two numbers added to the third. Figure 2 below shows an example. 15

Write the HTML and JavaScript code required to develop such functionality.

The figure consists of two side-by-side screenshots of a web browser window. Both screenshots have a header bar with a globe icon, 'Document', and standard browser controls (back, forward, search). Below the header is a search bar with the placeholder 'Search Google or type a URL'. The main content area contains three horizontal text input fields stacked vertically. Below these fields is a 'Calculate' button. In the first screenshot, all three input fields are empty. In the second screenshot, the top field contains '3', the middle field contains '4', and the bottom field contains '5'. To the right of the bottom field, there is an output field labeled 'Result =' followed by the value '17'.

Figure 2: example for question 4.a)

- b) Differentiate between Responsive and Adaptive Web sites. 5
- c) Compare between fixed and flexible web page design strategies. 5

5. a) What is Responsive Web Design? What are its advantages? 5  
 b) Write short notes on the CSS property *transform* and its different possible values. 5  
 c) Write the HTML code to generate the web page given in Figure 3 below. 15

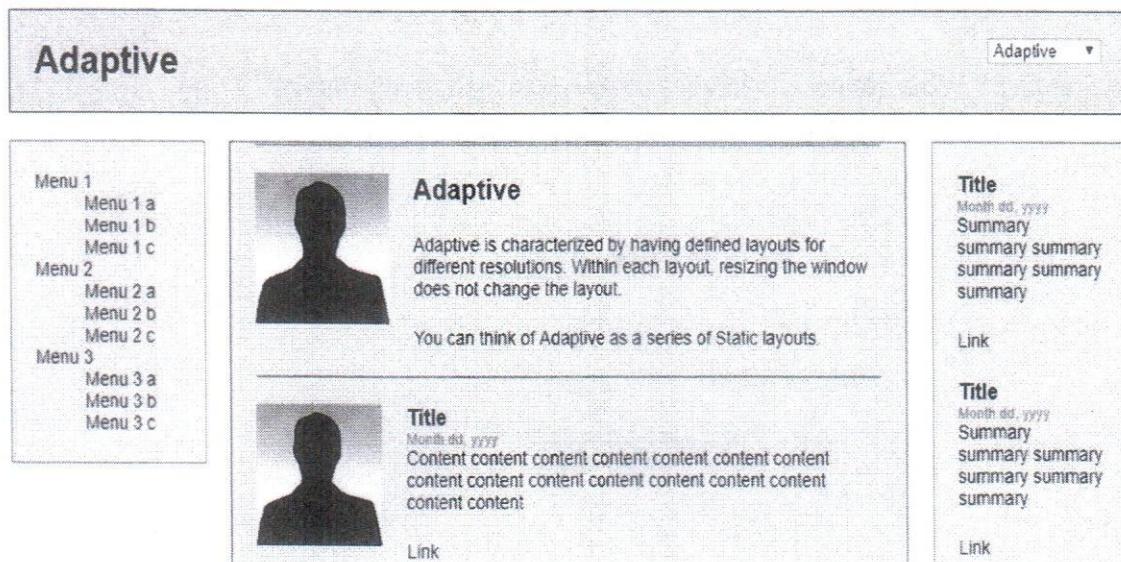


Figure 3:

## Instructions:

- The name of the image is 'avatar.jpg'
- Make proper use of margins, padding and borders if necessary.
- The left section (Menu 1, Menu 2 and Menu 3) is a definition list and each of the elements is containing links.

6. a) What are COOKIES? Explain how cookies work. Give practical examples of how cookies can be created, edited, and deleted. 10  
 b) What are super global variables in PHP? Give practical examples and how they are used. 6  
 c) A business site has 12 web pages. Business owner wants to show a message for each visitor at the top-right corner of the website. That message should contain visitor's IP address, and arrival date and time of current session. How can you do that for the businessman? 9
7. a) What are the differences between GET method and POST method in PHP? Explain where to use and where not to use each one of these methods with examples. 10  
 b) Given the following unordered list, 6
- Home
  - About
  - Services
  - Contact

Write CSS code required to transform the above list into a navigation bar list as follows, Assume the normal tags where used to create the list



- c) What is Name Space in a DNS system? 4
- d) With examples write the differences between `document.querySelector()` and `document.querySelectorAll()`? Give an example 5
8. a) What is AJAX? What are the advantages of AJAX to web programmers? 4
- b) Assume that you have the following To-do list webpage. 21

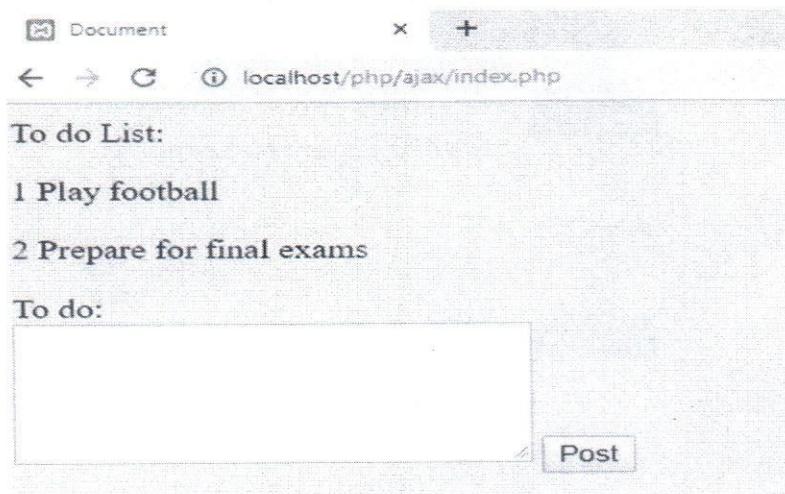


Figure 4:

- i. Write a PHP file, `ajax_to_do.php`, to generate the above page and also uses AJAX to send a POST request to a PHP file named `post_to_do.php`.
- ii. The PHP file, `post_to_do.php`, should connect and store the newly added to-do item into the database and return true if successful or false otherwise.
- iii. Write a JavaScript function named `updateTodo()` that will use the DOM to add the new item to the already existing ordered list.

(Note: You can assume all database connectivity information)

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4585: Computer Networks**

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

**There are 8 (eight) questions. Answer any 6 (six) of them.**

**Figures in the right margin indicate marks.**

1. a) What is the slot time in CSMA/CD? Explain how the slot time is related to the maximum network length. Explain why a minimum frame size is required for Ethernet. 3+6+4  
b) An Ethernet MAC sublayer receives 3040 bytes of data from the upper layer. Can the data be encapsulated in one frame? If not, how many frames need to be sent? What is the size of the data in each frame? 4  
c) Write short notes on any two of the followings: 4×2
  - i. Bluetooth    ii. Go-Back-N ARQ    iii. Network Allocation Vector (NAV)
  
2. a) Derive the maximum achievable throughput of a pure ALOHA network. Derive the formula to determine the average transfer delay of a pure ALOHA network. 4+7  
b) What do you mean by vulnerable time? “The vulnerable time in ALOHA depends on the frame transmission time, whereas it depends on the propagation delay in CSMA” - Justify the statement in your own word. 2+7  
c) In CSMA/CA, contention window (CW) changes according to the binary exponential back-off strategy. The initial value of the contention window ( $CW_{min}$ ) is 64. If a station requires 4 transmission attempts to successfully transmit a frame, what would be the back-off counter value for those transmission attempts? 5
  
3. a) Name three ICMPv4 query message and three error-reporting messages. Depict the encapsulation process of ICMPv4 error messages. Under what circumstances no ICMPv4 error messages is generated? 3+3+3  
b) Find the class and default mask of the following IPv4 address. Mention the number of possible IP addresses in each IP class. 3 X 2
  - i. 11000001.00000010.1111110.00000000    ii. 25.23.12.25    iii. 172.32.25.14
  
- c) A University is granted the address block 18.15.40.0/24, which contains 256 addresses. The university has six departments and needs to divide the addresses into six sub blocks of 128, 64, 32, 16, 8, and 8 addresses. Design the sub blocks and give the slash notation for each sub block that are assigned to different departments. With the aid of a diagram, show the configuration of the University network and answer the following questions: 10
  - i. What are the valid subnets?
  - ii. What are the broadcast addresses for each subnet?
  - iii. What are the valid hosts in each subnet?

4. a) Both IPv4 and IPv6 assume that packet may have different priorities or precedence. Explain how each protocol handles this issue. 6
- b) In an *IPv4* datagram, the M-bit is 0, the value of HLEN is 5, the value of total length is 200, and the fragment offset value is 200. What is the number of the first byte and number of the last byte in this datagram? Is this the last fragment, the first fragment, or a middle fragment? 6
- c) Mention the benefit of dropping the checksum field from IPv6 header. Does it introduce any potential danger of forwarding erroneous packets by IPv6? Explain. 6
- d) Briefly explain the major functionalities of Address Resolution Protocol (ARP) of TCP/IP protocol suite? 7

5. a) Write short notes on any two of the followings: 2 × 4
- i. Longest Mask Matching    ii. Address Aggregation    iii. Counting to Infinity (C2I)
- b) How does link state routing differ from distance vector routing? Consider the network given in Figure 1. With the indicated link costs, use Dijkstra's shortest-path algorithm used in link state routing to compute the shortest path from X to all network nodes. Prepare the routing table for node X. 4+6

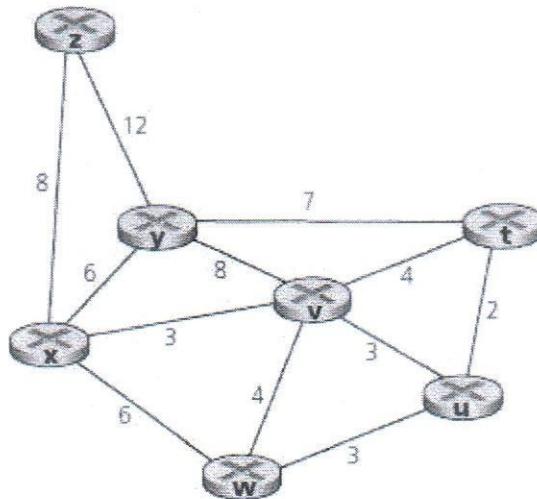


Figure 1: Network for Question 5.b)

- c) What is the C2I (counting to infinity) problem of distance-vector routing? Mention some of the methods to eliminate the problem. 5+2
6. a) A TCP client opens a connection using an initial sequence number (ISN) of 14,534. The TCP server opens the connection with an ISN of 21,732.
- Show the three TCP segments during the **three-way handshaking** connection establishment.
  - Show the contents of the segments during the connection termination using **four-way handshaking with half-close**.
- (Use timeline in y-axis for each side to show the **states** and the relative duration of the client and the server.)
- b) Briefly explain the acknowledgement and retransmission policy of TCP error control mechanism. 6+6
- c) Name different control flags in a TCP segment. Mention the minimum and maximum size of a TCP segment header. 3+2

7. a) How does congestion control differ from flow control in TCP? Suppose you have a TCP source, which starts transmission from segment number 15 with initial value of slow start threshold ( $ssth$ ) 65000. The size of the receiver window ( $rwnd$ ) is always larger than the congestion window ( $cwnd$ ). Draw the timing diagram (time axes toward the bottom of the page for both the source and destination) for the transmission of segments at least up to 25. The diagram should include slow start, congestion avoidance, and one packet loss identified by triple duplicate acknowledgment and one by time out. 3+10
- b) Briefly explain the significance of Persistence timer and TIME-WAIT timer in TCP? A host sends five packets and receives three acknowledgments. The time is shown as hour:minute:seconds. 6+6
- i. Segment 1 was sent at 0:0:00.
  - ii. Segment 2 was sent at 0:0:05.
  - iii. ACK for segments 1 and 2 received at 0:0:07.
  - iv. Segment 3 was sent at 0:0:20.
  - v. Segment 4 was sent at 0:0:22.
  - vi. Segment 5 was sent at 0:0:27.
  - vii. ACK for segments 3 and 4 received at 0:0:45.
  - viii. ACK for segment 5 received at 0:0:65.
- Calculate the values of  $RTT_M$ ,  $RTT_S$ ,  $RTT_D$ , and RTO of the retransmission timer of TCP. Given that the original RTO is 6 seconds.
8. a) Mention the major security goals of a computer network. How does symmetric key cryptography differ from asymmetric key cryptography? 2+4
- b) How do the classical ciphers differ from the modern ciphers? Encrypt the message "successful" using the Playfair cipher using the key "Crypto". 4+4
- c) Organizations with strict security often enforce password policies in order to make password management more secure. What could such policies be? Give examples. Discuss in what ways strict password policies may actually make password management less secure. 6
- d) Write a short note on any one of the followings: 5
- i. Replay Attack
  - ii. Reflection Attack

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS:150**

**CSE 4703: Theory of Computing**

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

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

1. a) Prove that every nondeterministic Turing Machine has an equivalent deterministic Turing Machine. 8  
 b) Following is the state diagram of a TM, M, give the sequence of configurations that M enters when started on the input string 00#0100#. 12

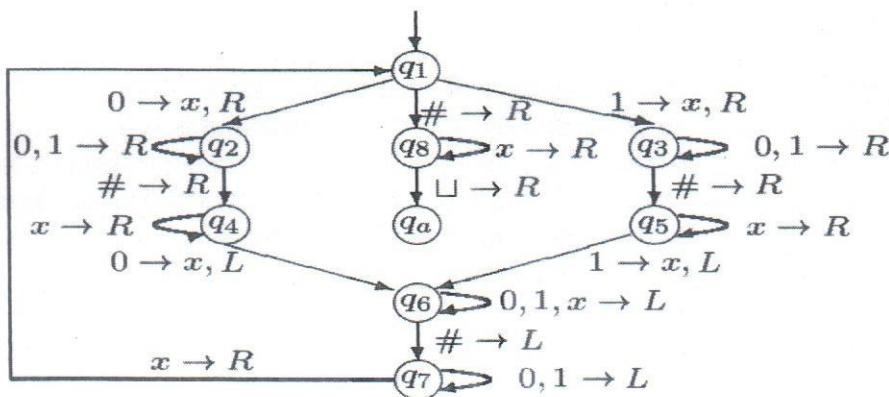


Figure 1: State diagram of a Turing Machine M

- c) Consider the grammar  $G = \{S \rightarrow 0S \mid 0S1S \mid \epsilon\}$ , show that the grammar G is ambiguous. 5  
 2. a) The classic game Pac-Man requires the player to navigate through a maze, eating pellets and avoiding the ghosts who chase him through the maze. Occasionally, Pac-Man can turn the tables on his pursuers by eating a power pellet, which temporarily grants him the power to eat the ghosts. When this occurs, the ghosts' behavior changes, and instead of chasing Pac-Man they try to avoid him. 12  
 The ghosts in Pac-Man have five behaviors listed below:  
 1. Randomly wander the maze  
 2. Chase Pac-Man, when he is within line of sight  
 3. Flee Pac-Man, after Pac-Man has consumed a power pellet  
 4. If dead, Return to the central base to regenerate  
 5. Game over after eats Pac-Man  
 Draw the state diagram of the NFA that emulates the behavior of a single ghost in Pac-Man.  
 b) Convert the following CFG to Chomsky Normal Form (CNF). 10

$$S \rightarrow ABA$$

$$A \rightarrow aA \mid \epsilon$$

$$B \rightarrow bB \mid \epsilon$$

- c) What do you understand by the terms Turing recognizable and Turing decidable? 3
3. a) Convert the following DFA in to a regular expression. Construct GNFA as an intermediary step. 15

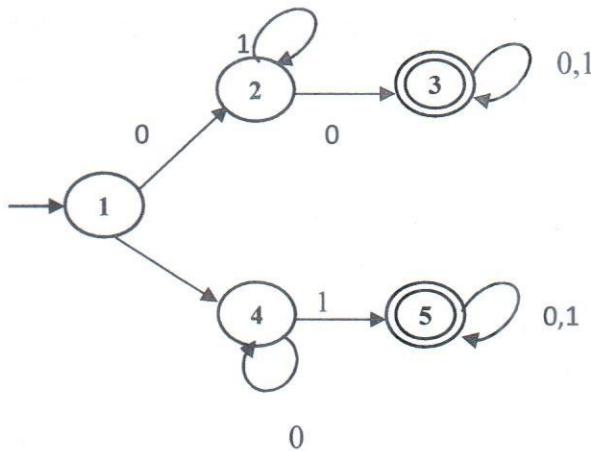


Figure 2: State diagram of a DFA

- b) Suppose you are asked to design a small part of a cricket game. This game is little bit different than usual cricket. In this game for a boundary batsman gets 1 run, for an over-boundary batsman gets 2 runs otherwise batsman gets no run. When a batsman's total run is multiple of 3 (i.e. 3, 6, 9, 12...etc.) it plays a sound of cheering crowd (Hurraaaaaaaaaay). When batsman first enters into the crease crowd also cheers for him. Simulate this feature of the game using a DFA. 10
4. a) Prove that  $\text{EQ}_{\text{DFA}}$  is a decidable language where  $\text{EQ}_{\text{DFA}} = \{\langle A, B \rangle \mid A \text{ and } B \text{ are DFAs and } L(A) = L(B)\}$ . 9
- b) Construct a PDA from the following Context Free Grammar (CFG). 12

$$\begin{aligned}
 R &\rightarrow XRX \mid S \\
 S &\rightarrow aTb \mid bTa \\
 T &\rightarrow XTX \mid X \mid \epsilon \\
 X &\rightarrow a \mid b
 \end{aligned}$$

Figure 3: Definition of the CFG

- c) Write a short note on Enumerators. 4
5. a) Prove that the set of real numbers  $R$  is uncountable. 11
- b) Give CFGs generating the following languages: 7+7
- i. Let  $L = \{w \in \{0, 1\}^* \mid \text{the language } L \text{ is the set of all binary integers that are even}\}$
  - ii. Let  $L = \{w \in \{a, b\}^* \mid \text{the first, middle, and last characters of } w \text{ are identical.}\}$
6. a) Prove that  $B = \{a^n b^n c^n \mid n \geq 0\}$  is not context free. Sketch an algorithm that shows that this language is indeed Turing recognizable. 15
- b) Give state diagrams of the following NFAs with the specified number of states recognizing each of the following languages. In all parts the alphabet is  $\{0, 1\}$ . 5+5
- i. The language  $\{w \mid w \text{ contains the substring } 0101\}$ , with five states.
  - ii. The language  $0^*1^*0^+$  with three states.
7. a) Prove the pumping lemma for context free languages. 10

- b) Convert the regular expression  $((a \cup b) \ a)^*$  to an NFA in a sequence of stages, starting from the smallest sub expression to larger sub expression. 10
- c) Write down the implementation level description of the Turing machine deciding the language  $B = \{w\#w \mid w \in \{0, 1\}^*\}$ . 5
8. a) Convert the following regular expression to NFA. 5+4  
 $(0 \cup 10)^* 010 (0 \cup 1)^+$   
 Show the computation of the NFA on input 010110.
- b) For each of the following languages, give two strings that are members and two strings that are not members of the languages. Assume the alphabet  $\Sigma = \{a, b\}$  in all parts. 2+2
- i.  $\Sigma^* a \Sigma^* b \Sigma^* a \Sigma^*$
  - ii.  $(a \cup ba \cup bb) \Sigma^*$
- c) Give regular expressions that generate each of the following languages. In all cases, the alphabet is  $\Sigma = \{a, b\}$ . 2×6
- iii.  $L = \{w \in \Sigma^* : |w| \text{ is odd}\}$
  - iv.  $L = \{w \in \Sigma^* : w \text{ has an odd number of } a's\}$
  - v.  $L = \{w \mid w \text{ contains at least two } a's, \text{ or exactly two } b's\}$ .
  - vi.  $L = \{w \in \Sigma^* : w \text{ ends in a double letter}\}. [(A \text{ string contains a double letter if it contains } aa \text{ or } bb \text{ as a substring.})]$
  - vii.  $L = \{w \mid w \text{ has length at least 3 and its third symbol is a } 0\}$
  - viii.  $L = \{w \mid w \text{ doesn't contain the substring } 110\}$

Liberty

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4709: Machine Learning**

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

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

1. a) Briefly explain the factors that you need to consider while choosing the appropriate machine learning algorithms. 12
  - b) Write short note on the followings:  $3 \times 3$ 
    - i. Overfitting and under-fitting problem
    - ii. Curse of dimensionality
    - iii. Bias-variance tradeoff
  - c) What is transfer learning? How can you transfer what is learned for one task to improve the learning in other related task? 2+2
2. A set of reasonably clean sample records was extracted by Barry Becker from the 1994 Census database. We are interested in predicting whether a person makes over 50K a year. For simplicity suppose we model the two features with two Boolean variables,  $x_1; x_2 \in \{0, 1\}$ ; and label  $y \in \{0, 1\}$ ; where  $y = 1$  indicates a person makes over 50K. In Figure 1, there are three positive samples ("+" for  $y = 1$ ) and one negative sample ("-" for  $y = 0$ ).

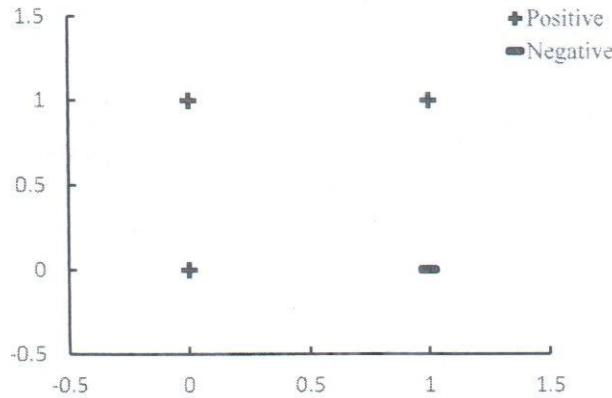


Figure 1: Sample dataset

Answer the followings:

- a) If we train a KNN classifier ( $K=1$ ) based on data in Figure 1, and then try to classify the same data. Which sample(s) must be misclassified by this classifier? 5
- b) For predicting samples in Figure 1, which model is better: Logistic Regression or Linear Regression? Explain why. 5
- c) Is there any logistic regression classifier using  $x_1$  and  $x_2$  that can perfectly classify the examples in Figure 1? How about if we change label of point (0; 1) from "+" to "-"? 5
- d) Suppose we have trained a linear regression model  $y = ax + b$  where  $a = 0.5$  and  $b = 1.0$ , on a set of training data points  $D = \{(1, 0; 1, 6); (1, 5; 1, 5); (3, 0; 2, 4)\}$ . Calculate the mean squared errors of this model on  $D$ . 5
- e) Suppose we learn a Naïve Bayes classifier from the examples in Figure 1, using MLE (maximum likelihood estimation) as the training rule. Determine the prior probabilities  $P(Y)$ , and conditional probabilities  $P(X_i|Y = 1)$ . 5

3. a) Write the differences between generative and discriminative models of probabilistic classifiers. 5  
 b) Write the algorithm of Naïve Bayes classifier for discrete valued feature. 7  
 c) Consider a set of training examples given in Table 1 to train a robot, 'RecycleBot' to predict whether or not an office contains a recycling bin.

Table 1: Training dataset

|    | Status  | Floor | Department | Office size | Recycle bin |
|----|---------|-------|------------|-------------|-------------|
| 1. | Faculty | Four  | CSE        | Medium      | Yes         |
| 2. | Student | Four  | EEE        | Large       | Yes         |
| 3. | Staff   | Five  | CSE        | Medium      | No          |
| 4. | Student | Three | EEE        | Small       | Yes         |
| 5. | Staff   | Four  | CSE        | Medium      | No          |

- i. Construct a Bayesian network that represents all attributes in the 'RecycleBot' example, assuming that the predicting attributes are pairwise independent. Provide the probability table for each of the predicting attributes. 5  
 ii. Show how a Naïve Bayesian classifier would classify the following instance: Status='Student', Floor='Four', Department='CSE', Office size='Small', Recycle bin=? 8
4. a) Create a neural network with only one hidden layer (of any number of units) that implements  $(AV \neg B) \otimes (\neg CV \neg D)$ . Draw your network, and show all weights of each unit.  
 b) Figure 2 below is a small convolutional neural network that converts a  $13 \times 13$  image into 4 output values. The network has the following layers/operations from input to output: convolution with 3 filters, max pooling, ReLU, and finally a fully-connected layer. For this network we will not be using any bias/o set parameters (b). 10

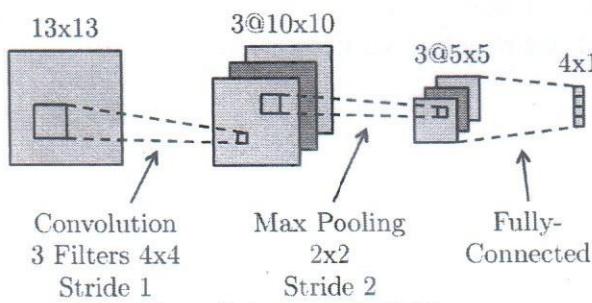


Figure 2: An example CNN

Answer the followings:

- i. How many weights in the convolutional layer do we need to learn? 2  
 ii. How many ReLU operations are performed on the forward pass? 2  
 iii. How many weights do we need to learn for the entire network? 2  
 iv. What is the disadvantage of a fully-connected neural network compared to a convolutional neural network with the same size layers? 4  
 c) What is vanishing gradient problem? How do you solve this problem? 5
5. a) Write the mathematical derivations of 'the objective function of support vector machine (SVM). 11  
 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. 5

- c) Consider the following training samples given in Figure 3.

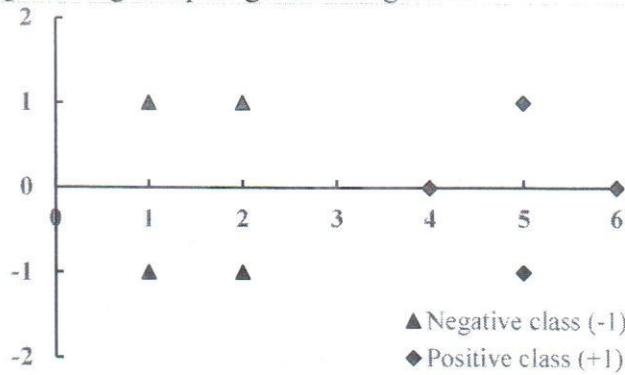


Figure 3: SVM training examples

Answer the followings:

- i. Write the augmented feature vectors of the training samples. 2
  - ii. Redraw the points in  $\mathbb{R}^2$  space indicating the support vectors. 2
  - iii. Mathematically determine the discriminative hyperplane and draw the line. 5
6. a) Write differences between bootstrapping and cross-validation. 5  
 b) Briefly explain the steps of Stacking as an ensemble classifier. 10  
 c) Suppose in a classification problem, you have the probabilities of the three models: M1, M2, M3 (shown in Table 2) for five observations of test data set. 5

Table 2: Output of three machine learning models

| M1  | M2  | M3  | Output |
|-----|-----|-----|--------|
| .70 | .80 | .75 |        |
| .50 | .64 | .80 |        |
| .30 | .20 | .35 |        |
| .49 | .51 | .50 |        |
| .60 | .80 | .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.

- d) Briefly explain the working principle of random forest algorithm. 5
7. a) Mrs. X has lost gender information of one of her customers, and does not know whether to make a skirt or trousers. The customer who is missing gender information has only the measurement of waist and hip which are 28 and 34 respectively. Using K-NN classifier with K=3, find the missing gender information. The training set is given in Table 3. 12

Table 3: Training set

| S/N | Waist (cm) | Hip (cm) | Gender |
|-----|------------|----------|--------|
| 1   | 28         | 32       | Male   |
| 2   | 33         | 35       | Male   |
| 3   | 27         | 33       | Female |
| 4   | 31         | 36       | Female |
| 5   | 28         | 34       | ?      |

- 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. 8

- c) Given the covariance matrix,

$$\begin{bmatrix} 2.0 & 8.0 \\ 8.0 & 0.6 \end{bmatrix}$$

5

Find out the first two principal vectors.

8. a) For the distance matrix (Table 4), perform the iterations of agglomerative clustering (single linkage) and draw the corresponding Dendrogram.

12

Table 4: Distance Matrix

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

- b) Suppose you have got the result (shown in Table 5) of the confusion matrix of IRIS dataset after applying a clustering algorithm.

Table 5: Confusion Matrix

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

- i. Find out the precision and recall from the confusion matrix.  
ii. Find out the F-Measure.  
iii. Find the cluster purity of individual clusters.
- c) "One of the problems with hierarchical clustering is that there is no objective way to say how many clusters are there." – Explain the assertion with example.

4

2

3

4

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4733: Digital Image Processing**

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

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

1. a) Describe the following morphological techniques:

- i. Extraction of Connected Component
- ii. Boundary Extraction
- iii. Hole Filling

3  
4  
4

- b) Consider the grayscale image in Figure 1, which shows a region of small circles enclosed by a region of larger circles. How can you detect the boundary that separates those two regions? Assume any necessary parameter values.

9

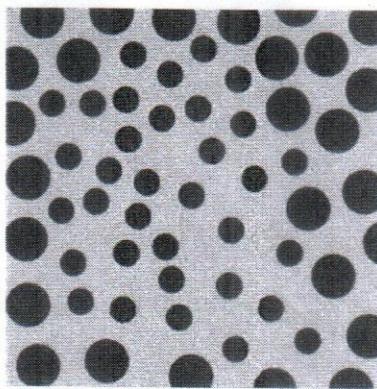


Figure 1.

- c) The top-hat transformation of a grayscale image  $f$  is defined as  $f$  minus its opening with a structuring element of  $b$ :

$$T_{\text{hat}}(f) = f - (f \circ b)$$

5

What kind of effects do you expect after top-hat transform?

2. a) Suppose you have applied a Sobel mask which produces strong responses for horizontal edges but no responses for vertical edges. Why does this mask also produce weak responses for  $+45^\circ$  and  $-45^\circ$  oriented edges?

5

- b) Describe the Hough Transform for detecting circles of any radius.

10

- c) Graph Theoretic approach can be used for detecting edges. How can you build a graph from an input image and find prominent edges in a particular orientation?

10

3. a) Is it possible to get 2D Fourier Transform by first taking 1D Fourier transform in the first dimension and then performing another 1D Fourier transform in the other dimension? Explain why.

7

- b) When do ringing effects appear in an image when Butterworth Filter has been applied in its Fourier Domain? Justify with necessary figures.

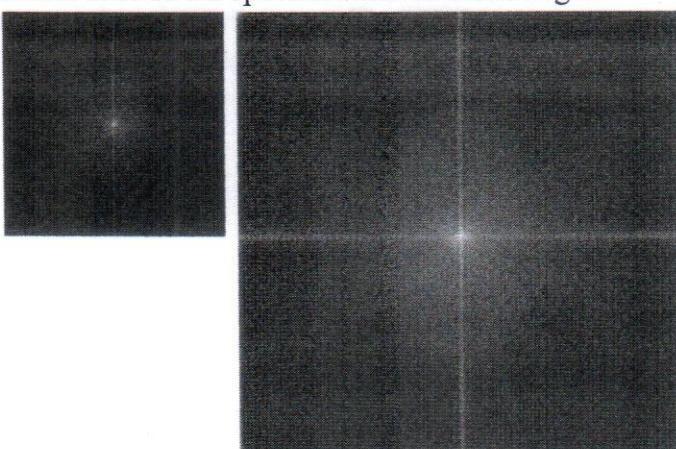
5

- c) Suppose you are provided with a  $3 \times 3$  spatial mask which enhance the edge structures more when applied directly on the image. Explain how an equivalent effect can be obtained with its frequency domain representation. Justify your choice.

8

- d) Why does Gaussian smoothing filter in the space domain have a different size than its equivalent representation in the frequency domain?

5

4. a) Given an image of size  $M \times N$ , you are asked to perform an experiment that consists of repeatedly lowpass filtering the image using a Gaussian lowpass filter with a given cutoff frequency  $D_0$ . You may ignore computational round-off errors. Let  $K$  denote the number of applications of the filter. Can you predict (without doing the experiment) the result (image) for a sufficiently large value of  $K$ ? Justify your result. 10
- b) The two Fourier spectra shown in Figure 2 are of the same image. The spectrum on the left corresponds to the original image, and the spectrum on the right was obtained after the image was padded with zeros. Explain the significant increase or decrease in signal strength along the vertical and horizontal axes of the spectrum shown on the right. 10
- 
- c) Which filter is more preferable: Gaussian filter or Butterworth filter? Justify your choice. 5
5. a) What is a histogram of an image?  
 i. What effect would setting to zero the lower-order bit planes have on the histogram of an image in general?  
 ii. What would be the effect on the histogram if we set to zero the higher-order bit planes instead? 5
- b) Explain why the discrete histogram equalization technique does not, in general, yield a flat histogram. Draw necessary illustrations. 10
- c) Image subtraction is used often in industrial applications for detecting missing components in product assembly. The approach is to store a “golden” image that corresponds to a correct assembly; this image is then subtracted from incoming images of the same product. Ideally, the differences would be zero if the new products are assembled correctly. Different images for products with missing components would be nonzero in the area where they differ from the golden image. What conditions do you think have to be met in practice for this method to work? 10
6. a) Differentiate between correlation and convolution. 5  
 b) Why does smoothing effect increases with the size of a square averaging filter? 5  
 c) What is isotropic filter? Prove that a Laplacian mask is isotropic. 1+5  
 d) 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 the important property 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 be zero also (you may ignore computational inaccuracies). Also, you may assume that the border of the image has been padded with the appropriate number of zeros. 9
7. a) High-definition television (HDTV) generates images with 1125 horizontal TV lines interlaced (where every other line is painted on the tube face in each of two fields, each field being of a second in duration). The width-to-height aspect ratio of the images is 16:9. The 5

fact that the number of horizontal lines is fixed determines the vertical resolution of the images. A company has designed an image capture system that generates digital images from HDTV images. The resolution of each TV (horizontal) line in their system is in proportion to vertical resolution, with the proportion being the width-to-height ratio of the images. Each pixel in the color image has 24 bits of intensity resolution, 8 bits each for a red, a green, and a blue plane. These three "primary" images form a color image. How many bits would it take to store a 2-hour HDTV movie?

- b) Develop an algorithm for converting a one-pixel-thick  $m$ -path to a 4-path. 7
- c) How would you implement the color equivalent of gray scale histogram specification (HS)? 8
- d) In a simple RGB image, the R, G, and B component images have the horizontal intensity profiles shown in the following diagram in Figure 3. What color would a person see in the middle column of this image? 5

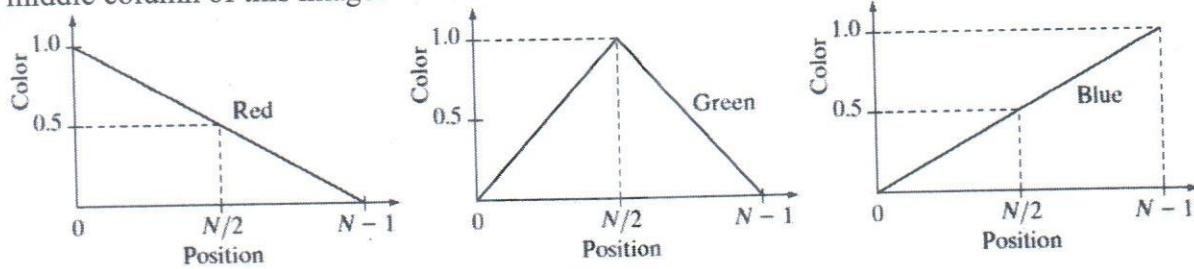


Figure 3.

8. Having heard about your success in getting highest grade in the *Digital Image Processing* course, you are contacted by a fluids company that wishes to automate bubble-counting in certain processes for quality control. The company has solved the imaging problem and can obtain 8-bit images of size  $700 \times 700$  pixels, such as the one shown in Figure 4. Each image represents an area of  $7 \text{ cm}^2$ . The company wishes to do two things with each image: (i) Determine the ratio of the area occupied by bubbles to the total area of the image, and (ii) count the number of distinct bubbles. Based on the material you have learned up to this point, propose a solution to this problem. In your solution, make sure to state the physical dimensions of the smallest bubble your solution can detect. State clearly all assumptions that you make and that are likely to impact the solution you propose. 25

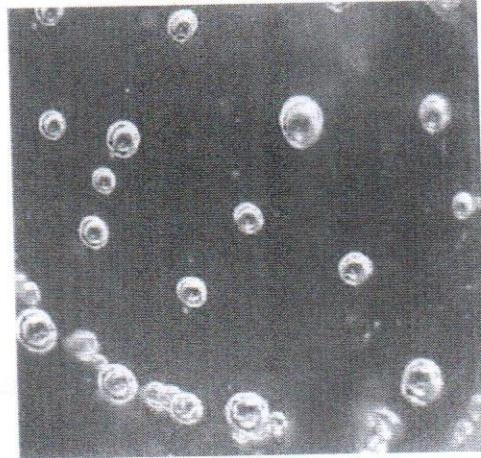


Figure 4.

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4739: Data Mining**

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

**There are 8 (eight) questions. Answer any 6 (six) of them.**

**Figures in the right margin indicate marks.**

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1. a) Present an example where data mining is crucial to the success of a business. What <i>data mining</i> functionalities does this business need (e.g., think of the kinds of patterns that could be mined)? Can such patterns be generated alternatively by data query processing or simple statistical analysis?                                                                                                                                                                                                                                                                                                                                        | 10  |
| b) Suppose that the data for analysis includes the attribute age. The age values for the data tuples are (in increasing order):<br>13, 15, 16, 16, 19, 20, 20, 21, 22, 22, 25, 25, 25, 25, 25, 30, 33, 33, 35, 35, 35, 35, 36, 40, 45, 46, 52, 70.<br>i. Use min-max normalization to transform the value 35 for age onto the range [0.0, 1.0].<br>ii. Use z-score normalization to transform the value 35 for age, where the standard deviation of age is 12.94 years.<br>iii. Use normalization by decimal scaling to transform the value 35 for age.<br>iv. Comment on which method you would prefer to use for the given data, giving reasons as to why. | 8   |
| c) What are the common repositories used for Mining in Software Repositories (MSR)?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 7   |
| 2. a) Why Data Integration is important? Discuss issues to consider during data integration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 10  |
| b) With the help of a diagram explain <i>Density-reachability</i> and <i>Density-connectivity</i> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 6   |
| c) What are the benefits of density-based clustering? How does DBSCAN find clusters?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 3+6 |
| 3. Suppose that a data warehouse consists of the four dimensions <i>date</i> , <i>spectator</i> , <i>location</i> , and <i>game</i> , and the two measures <i>count</i> and <i>charge</i> , where <i>charge</i> is the fare that a spectator pays when watching a game on a given date. Spectators may be students, adults, or seniors, with each category having its own charge rate.                                                                                                                                                                                                                                                                       |     |
| a) Draw a star schema diagram for the data warehouse.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 10  |
| b) Starting with the base cuboid [ <i>date</i> , <i>spectator</i> , <i>location</i> , <i>game</i> ], what specific OLAP operations should you perform in order to list the total charge paid by student spectators at GM Place in 2010?                                                                                                                                                                                                                                                                                                                                                                                                                      | 8   |
| c) If each dimension has five levels (including all), such as “ <i>date &lt; week &lt; month &lt; year &lt; all</i> ”, how many cuboids will this cube contain (including the base and apex cuboids)?                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 7   |

4. a) Today's consumers are faced with millions of goods and services when shopping online. Recommender systems help consumers by making product recommendations that are likely to be of interest to the user such as books, CDs, movies, restaurants, online news articles, and other services. Data mining plays a major role in these recommender systems. What are the approaches researchers use for these systems? What major challenges they face? 7+3  
 b) What is *Privacy-Preserving Data Mining* (PPDM)? Categorize the PPDM methods. 3+4  
 c) Briefly discuss the achievements of Mining Software Repositories (MSR). 8
5. A survey was performed in Facebook group “*Pavilion de IUT*”, where group members voted their favorite combination of team IUT for Inter University Futsal Tournament. Result of that survey is listed in Table 1.  
 Let min\_sup = 30% and min\_conf = 60%.
- Table 1: Five-a-side teams for Question 6.
- | Team ID | Team Players                            |
|---------|-----------------------------------------|
| T1      | {Ishmam, Khalil, Tajdeed, Sabit, Shams} |
| T2      | {Momin, Khalil, Tajdeed, Sabit, Sayem}  |
| T3      | {Fardin, Khalil, Tajdeed, Akik, Shams}  |
| T4      | {Momin, Khalil, Tajdeed, Sabit, Sayem}  |
| T5      | {Momin, Khalil, Tajdeed, Akik, Shams}   |
| T6      | {Momin, Khalil, Ishmam, Akik, Shams}    |
| T7      | {Fardin, Khalil, Ishmam, Sabit, Sayem}  |
| T8      | {Momin, Khalil, Tajdeed, Akik, Shams}   |
| T9      | {Momin, Fardin, Ishmam, Akik, Sayem}    |
| T10     | {Momin, Khalil, Tajdeed, Sabit, Shams}  |
| T11     | {Fardin, Khalil, Akik, Sifat, Sayem}    |
| T12     | {Momin, Khalil, Tajdeed, Sabit, Shams}  |
| T13     | {Momin, Khalil, Ishmam, Sabit, Sayem}   |
| T14     | {Fardin, Khalil, Akik, Sabit, Shams}    |
| T15     | {Momin, Khalil, Tajdeed, Sabit, Sayem}  |
| T16     | {Momin, Zakaria, Tajdeed, Sifat, Shams} |
| T17     | {Momin, Khalil, Tajdeed, Akik, Shams}   |
| T18     | {Fardin, Khalil, Ishmam, Sabit, Sayem}  |
| T19     | {Momin, Akik, Ishmam, Sabit, Sayem}     |
| T20     | {Zakaria, Khalil, Ishmam, Sabit, Sayem} |
- a) Find all frequent sets of players using Apriori algorithm. 20  
 b) Is correlation measure really necessary for association rules? Give your opinion with proper justification. 5
6. a) Why is mobile crowdsensing preferred over traditional sensor networks? In which case it fails? 5+3  
 b) Discuss the major challenges in vehicular crowdsensing with appropriate example? 7  
 c) For the data of Table 1 in Question 5, List all the strong association rules (with support s and confidence c) matching the following meta rule, where X is a variable representing group member, and Player<sub>i</sub> denotes variables representing Players (e.g., “Momin,” “Sabit”):  
 $\forall x \in Team, choose(X, Player_1) \wedge choose(X, Player_2) \Rightarrow choose(X, Player_3) [s, c]$  10

7. a) Give an application example where global outliers, contextual outliers, and collective outliers are all interesting. Based on your application answer the followings:      6+9
- What are the attributes?
  - What are the contextual and behavioral attributes?
  - How is the relationship among objects modeled in collective outlier detection?
- b) Define  $DB(r, \pi)$  – outliers. Why are they global? Explain a scenario where  $DB(r, \pi)$  fails.      3+3+4
8. Table 2 lists the points achieved by top six teams in 4 major football leagues.

Table 2: Data for question 8

| Teams | EPL | La Liga | Serie A | Bundesliga |
|-------|-----|---------|---------|------------|
| O1    | 98  | 86      | 89      | 75         |
| O2    | 97  | 75      | 76      | 73         |
| O3    | 72  | 68      | 66      | 66         |
| O4    | 71  | 58      | 65      | 55         |
| O5    | 70  | 58      | 62      | 55         |
| O6    | 66  | 56      | 62      | 54         |

- a) Find the distance matrix using *Minkowski distance* between the objects in Table 2, using  $q = 4$ .      10
- b) Draw the dendograms of Hierarchical Agglomerative Clustering applied on the data in table 2 using the followings:      15
- Nearest-neighbor clustering algorithm
  - Farthest-neighbor clustering algorithm
  - Average linkage algorithm

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**MATH 4741: Mathematical Analysis**

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

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

1. a) An urn always contains 2 balls. Ball colors are red and blue. At each stage a ball is randomly chosen and then replaced by a new ball, which with probability 0.8 is the same color, and with probability 0.2 is the opposite color, as the ball it replaces. If initially both balls are red, find the probability that the fifth ball selected is red. 8
- b) Suppose that balls are successively distributed among 8 urns, with each ball being equally likely to be put in any of these urns. What is the probability that there will be exactly 3 nonempty urns after 9 balls have been distributed? 8
- c) On any given day Gary is either cheerful (C), so-so (S), or glum (G). If he is cheerful today, then he will be C, S, or G tomorrow with respective probabilities 0.5, 0.4, 0.1. If he is feeling so-so today, then he will be C, S, or G tomorrow with probabilities 0.3, 0.4, 0.3. If he is glum today, then he will be C, S, or G tomorrow with probabilities 0.2, 0.3, 0.5. In the long run, what proportion of time is the process in each of the three states? 9
  
2. a) Consider a gambler who at each play of the game has probability  $p$  of winning one unit and probability  $q = 1 - p$  of losing one unit. Assuming that successive plays of the game are independent, what is the probability that, starting with  $i$  units, the gambler's fortune will reach  $N$  before reaching 0? 13
- b) "In a city, on average most of the buses are empty but according to passengers everyone found their bus to be crowded" – Are the statements contradictory? Explain with justification. 6
- c) Suppose Max and Patty decide to flip pennies; the one coming closest to the wall wins. Patty, being the better player, has a probability 0.6 of winning on each flip. (a) If Patty starts with five pennies and Max with ten, what is the probability that Patty will wipe Max out? (b) What if Patty starts with 10 and Max with 20? 3+3
  
3. Consider a shoe shine shop consisting of two chairs. Suppose that an entering customer first will go to chair 1. When his work is completed in chair 1, he will go either to chair 2 if that chair is empty or else wait in chair 1 until chair 2 becomes empty. Suppose that a potential customer will enter this shop as long as chair 1 is empty. (Thus, for instance, a potential customer might enter even if there is a customer in chair 2.) If we suppose that potential customers arrive in accordance with a Poisson process at rate  $\lambda$ , and that the service times for the two chairs are independent and have respective exponential rates of  $\mu_1$  and  $\mu_2$ , then
  - a) What proportion of potential customers enters the system? 7
  - b) What is the mean number of customers in the system? 6
  - c) What is the average amount of time that an entering customer spends in the system? 6
  - d) Find  $\pi_b$ , equal to the fraction of entering customers that are blockers? That is, find the fraction of entering customers that will have to wait after completing service with server 1 before they can enter chair 2. 6
4. a) Explain with examples about three different behaviors of arrival for a queueing model. 6
- b) Explain birth and death queueing models. Show and explain the conditions that we impose on the following queueing model to model them as birth and death model:
  - i. The M/M/1 queueing system
  - ii. The M/M/1 queueing system with balking2+6

- c) Consider a single-server queue where customers arrive according to a Poisson process with rate  $\lambda$  and where the service distribution is exponential with rate  $\mu$ , but now suppose that each customer will only spend an exponential time with rate  $\alpha$  in queue before quitting the system. Assume that the impatient times are independent of all else, and that a customer who enters service always remains until its service is completed.
- Model it as birth and death model (impose condition on arrival rate and departure rate).
  - determine the proportion of arrivals that receive service,  $\pi_s$  and verify it.
  - Let,  $a_n$  equal to the proportion of arrivals that find  $n$  in the system. Derive equation for  $a_n$ .
5. a) Explain: M/M/1 and M/M/k queueing systems. 5
- b) For an M/M/1 queueing system with infinite capacity derive equations for L and W. Make any necessary assumptions for the derivation and show step by step approach. 15
- c) What is the general condition that must be satisfied for limiting probabilities to exist in most single-server queueing systems? Explain mathematically/logically. 5
6. a) Suppose that customers arrive at a Poisson rate of one per every 12 minutes, and that the service time is exponential at a rate of one service per 8 minutes. What are L and W for M/M/1 with infinite queue? Increase the arrival rate by 20% and recalculate L and W. Compare the L & W of both scenarios and explain why we see such changes in the values. 10
- b) For an M/M/1 queueing system with finite capacity N derive equations for L and W. Make any necessary assumptions for the derivation and show step by step approach. 15
7. a) Suppose that it costs  $c\mu$ /hour to provide service at a rate  $\mu$ . Suppose also that we incur a gross profit of A\$ for each customer served. If the system has a capacity N, what service rate  $\mu$  maximizes our total profit? Let,  $N = 2$ ,  $\lambda = 1$ ,  $A = 10$ ,  $c = 1$ . 10
- b) Consider yourself to be a very devoted researcher working under a professor. Your devotion is so high that you don't get the chance to go outside of the room and perceive the weather by yourself. But a thing that you have noticed that your professor sometimes brings umbrella and sometimes he doesn't. After asking your professor each day you learn that when it's sunny outside 20% of time he brings umbrella and if it is rainy then 40% of time he forgets the umbrella. Another fact that you have noticed is that if today is sunny tomorrow is sunny with 80% probability and if today is rainy tomorrow is rainy with 60% probability. You should be aware that in your environment weather can be of only two kinds, sunny and rainy. Given that a random day is sunny with probability 2/3 and rainy with probability 1/3, answer the following questions with respect to the scenario described above:
- What kind of model the above scenario fits into? Draw the transition diagram of that model.
  - For four consecutive days, you observe that the professor didn't bring umbrella in the first two days and brought umbrella in the last two days. What was the weather like in those days? (Show calculations with proper reasoning for your answer)
- 5+10
8. In the tv-show called "Game of Thrones" characters die with a rate  $\lambda = .6/\text{episode}$ . Considering you haven't watched the show before and you start watching it. You will watch the series for at least two episodes but if any of the characters die within those episodes you will stop watching after the second episode. Otherwise you will continue to watch the series past the second episode until any character dies. Answer the following question based on given scenario:
- $P(\text{watch for more than two episodes})$  5
  - $P(\text{watch for more than two episodes but less than five episodes})$  5
  - $P(\text{watching at least two characters die})$  5
  - $E[\text{number of deaths}]$  5
  - $E[\text{total watch time}]$  5

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 100**

**Hum 4741: Business Communication and Law**

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

**There are 5 questions in Section-A and 3 Questions in Section-B. Answer any 4 (four) from Section-A, and any 2 (two) from Section-B.**

Figure in the right margin indicate Marks.

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**Section: A (Answer any four from this section)**

1. a) A job circular by Banglalink was published in "The Daily Star" on April 25, 2019 to recruit some "Network Planning Specialist Engineer" under technology division. Major job responsibilities include: 7
- Analyze the fault rate of power elements from field data, and other reports; consider the network growth and prepare requirements to solve the problems.
  - Align teams to allocate necessary budget for network growth and corrective measure.
  - Ensure on time ordering, work order, asset requisition of power equipment.
  - Ensure emergency stock of power elements for critical equipment for capacity sites.
  - Evaluate the new power solution and recommendation for network.
  - Provide technical specifications and relevant support to purchase equipment.
  - Manage business partners to get the most effective and efficient services.
- Required Academic Qualifications, Experiences, Knowledge & Skills
- B.Sc. in CSE/EEE/ETE/ECE from any reputed/recognized university.
  - Minimum 3 years of relevant experience.
  - knowledge of power elements inventory management, power system budget utilization, and equipment specification finalization process.
  - Analytical ability, reporting, performance and fault analysis.
  - Physical verification of equipment, work order and assets requisitions.
- Write a "**cover letter**" to the head of HR, Banglalink, Gulsan-1213, Dhaka assuming that you have required skills, experiences and educational qualifications.
- b) Resume is the most important first written communication with a potential employer. About 6 80% of the applications is rejected because of the non-professional and traditionally prepared resume with cluttered information. Fortunately, there are certain guidelines to prepare professional resume with relevant information in either reverse-chronological format or functional format. Discuss the guidelines for writing a professional resume keeping your qualifications and quality level in your mind.
- c) In an interview, to get yourself differentiated from others you require to create primacy and recency effect in addition to providing answers smartly based on identifying sweets spot. How does the knowledge of business communication help you to handle an interview to create primacy and recency effect? Explain. 4
2. a) Times are hard for Robo solutions, a small local company that creates assembly line robotics. 5 Lately, the clients have few and far between. But today, the sales staff got an encouraging news: James Prichett, president of a nearby tool and die company, has inquired about the possibility of the company's designing a series of computer-run robots for key processes in the plant. There is a hitch, though: it is Sarah's turn to try to snare his business and Prichett is known to prefer dealing with men. Do you, as Robo solution sales manager, send Sarah anyway, or do you send one of your male salespeople to get Prichett's business, giving Sarah a shot at the next potential client? How would you solve this communication-ethics problem?

b) Think of a recent transaction you had with a person from India. How did the contexts of communication (larger contexts, relationship between communicators, and particular context) influence the outcome of your transaction? Describe with examples. 6

c) After noticing that some workers were starting work late and finishing early, a Department Head wrote this message to subordinates:

It is apparent that many of you are not giving the company a full day's work. Thus, the following procedures are implemented immediately:

- After you clock in, you will proceed to your workstations and will be ready to begin work promptly at the start of the work period.
- You will not take a coffee break on the job at the beginning of the work period. You will wait until your designated break times.
- You will not participate in social gatherings at any time during the workday except during designated break periods.
- You will terminate work activities no earlier than 10 minutes prior to the end of the work period. You will use the 10 minutes to put up equipment, clean equipment, and police the work area.

The message was not well-received by the workers. In fact, it led to considerable anger and confusion. Using the discussion of communication planning process, explain where the department head's problem solving went awry. What alternative techniques he may choose?

3. a) Assume, you are the head of supply chain management in Unilever Ltd. If you require to persuade your boss to implement some kind of cross-cultural training in the company, what kind of evidence might help you make a convincing case? Discuss with relevant examples. 5

b) Think of some English words that do not have precise equivalents in some other culture. 7 What do you think may be the reasons behind these language equivalency problems? How would you attempt to explain these words to a person from that culture?

c) Evaluate the statements from the point of selecting words for communications: "I'm not going to simplify my writing for my readers. That would be talking down to them. Plus, if they cannot understand English, that's their problem." 5

4. a) "No one is persuaded to do something without any major reason. Based on your knowledge you have about your readers, you require to choose and develop targeted reader benefits and relate it with different types of appeals." -Evaluate the statements focusing on general advices about persuasion. 6

b) "The business communication course can be summarized in one sentence: In all way of communication, both verbal and nonverbal, focus on You-Viewpoint; whether you are choosing words, developing sentences, giving emphasis in sentences or developing persuasive paragraphs." - Discuss. 6

c) What do you mean by proposal? Discuss various types of proposals along with their advantages and disadvantages. If you were asked to write a proposal, which type of proposal would you prefer and why? 5

5. a) Why directness is so used in internal-operational communications? Can it be overdone? 4 When indirectness is appropriate?

b) Assume, you are a vice president of ABC computer limited. Today, your boss has assigned a task of responding to an email from your previous educational institution. This worthy institution has asked ABC ltd. to be the platinum sponsor for ICT Fest-2020. The request is very persuasive. It points out that the funding is really essential to make the event successful. It creates opportunity for the undergraduates to flourish their latent talents. They have also emphasized the alumni relationship in addition to giving reference of one of your most

respected teachers. You have been moved by the persuasion and would like to contribute. But you cannot contribute now because ABC policy does not permit it. Each year ABC Ltd. earmarks a fixed amount for contribution purposes. Then, it sponsors this amount to that causes that a committee of its executives considers worthier. Unfortunately, all the money earmarked for 2020 has already been donated to BUET. You are forced by the situation to say no to the request, at least for now. Write an email to the educational institution refusing the request while maintaining good relationships.

- c) Evaluate the statement: "it is hard to argue against courtesy. But businesspeople don't time to spend extra effort on it. Anyway, they want their documents to go straight to the point without wasting words for managing emphasis with positive effects and without sugar coating."

**Section: B** (Answer any **two** from this section)

6. a) What is critical information infrastructure? How does digital forensic lab ensure quality control of critical information infrastructure? 4
- b) Imagine, after completing your graduation from Islamic University of Technology, you want to launch a business along with your friends. That's why, you need to enter into a contract to share capital, profit and loss. How would you define the relationships between you and your friends? If you want your contract to be legally enforceable, what conditions will you have to fulfill? 7
- c) Critically evaluate the statement: "A minor cannot be a partner, but with the consent of all other partner, the minor can be entitled to all the benefits of the partnership with certain rights and liabilities." 5
7. a) "Receiving profit from property with common interest or receiving share of profit of a particular business may not comprise partnership." Discuss the statement with relevant examples. 4
- b) What do you mean by dissolution of a partnership firm? If you want to dissolve a partnership relationship, in how many ways you can do so? Explain. 6
- c) What do you mean by consideration in a contract? Is it possible to establish a contract without consideration? What rule do you have to remember regarding consideration if you want to enter into a contract? 6
8. a) Why communication skills are so important for IT professionals? Discuss with relevant examples. 5
- b) It is also possible to communicate with another person without using any words. Nonverbal communication may be expressed through body languages, distance, time, tone, frankness and even through your handshakes. These languages carry important impact on business relationship. Discuss the impact of nonverbal communication on business relationship. 6
- c) Assume that your boss, the director of marketing, has asked you to prepare an oral report for the marketing team on the status of current sales campaign. The sales messages being "pushed" to potential customers have been designated for viewing on three different technologies: PCs, tablets, and smartphones. List in order to give presentation, the contents you might include, along with any visuals that would go with it. 5

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**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.**

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

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- |    |                                                                                                                                                                                                                                                                                                                                     |              |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 1. | a) Briefly define few security mechanisms.                                                                                                                                                                                                                                                                                          | 7            |
|    | b) Which security mechanism(s) are provided in each of the following cases?                                                                                                                                                                                                                                                         | $3 \times 2$ |
|    | i. A school server disconnects a student if he is logged into the system for more than two hours.                                                                                                                                                                                                                                   |              |
|    | ii. A professor refuses to send students their grades by e-mail unless they provide student identification they were preassigned by the professor.                                                                                                                                                                                  |              |
|    | c) Discuss few uses of <i>Text Cover</i> in modern <i>Steganography</i> .                                                                                                                                                                                                                                                           | 7            |
|    | d) Distinguish between a stream cipher and a block cipher.                                                                                                                                                                                                                                                                          | 5            |
| 2. | a) Discuss the significance of <i>Mixer</i> in <i>Feistel Cipher</i> .                                                                                                                                                                                                                                                              | 8            |
|    | b) Use the <i>Vigenere</i> cipher with keyword "HEALTH" to encipher the message "Life is full of surprises".                                                                                                                                                                                                                        | 8            |
|    | c) Find the result of $(x^5+x^2+x) \otimes (x^7+x^4+x^3+x^2+x)$ in $GF(2^8)$ with irreducible polynomial $(x^8+x^4+x^3+x+1)$ . Note that we use the symbol $\otimes$ to show the multiplication of two polynomials.                                                                                                                 | 9            |
| 3. | a) Define a <i>State</i> in AES.                                                                                                                                                                                                                                                                                                    | 4            |
|    | b) Draw the block diagram of AES Encryption and Decryption process.                                                                                                                                                                                                                                                                 | 10           |
|    | c) Which of the four transformations defined for AES change the contents of bytes?                                                                                                                                                                                                                                                  | 3            |
|    | d) State the significance and operational detail of ' <i>MixColumns</i> ' and ' <i>AddRoundKey</i> ' steps in AES.                                                                                                                                                                                                                  | $4 \times 2$ |
| 4. | a) Alice wants to use RSA to encrypt the message M=88 and send it to Bob. Bob has chosen two prime numbers (p=5 and q=11) to calculate the public number needed for the RSA keys. Furthermore, Bob has selected the number e=3 to use in his public key.                                                                            |              |
|    | i. What is the resulting private key and public key published by Bob?                                                                                                                                                                                                                                                               | 4            |
|    | ii. What is the resulting ciphertext block C that Alice will send to Bob using RSA to encrypt her message (M=88)?                                                                                                                                                                                                                   | 4            |
|    | b) With the aid of a diagram explain the authenticated Diffie-Hellman key exchange.                                                                                                                                                                                                                                                 | 9            |
|    | c) Revocation of public key certificates is an important part of PKI. But certificates also carry expiration dates, so there are two ways in which a certificate can be invalidated (revocation and expiration). What are the reasons for having two ways of invalidating certificates? Would it not be sufficient with revocation? | 8            |

5. a) Explain the ticket invalidation problem in Needham-Schroeder protocol. Draw the authentication process of Otway-Rees protocol that removed the ticket invalidation problem. 5+5
- b) A secure hash function gives a condensed version of a message (it is a “lossy” compression function). 5×3
- i. What are the most important properties of a secure hash function for message authentication?
  - ii. Why are “salts” normally used with hash function when storing passwords in databases?
  - iii. Why do MD5 and SHA-1 require padding of messages that are already a multiple of 512 bits?
6. a) The IPSec specification defines two modes of applying IPSec protection to a packet. 6
- i. What are the two modes? What is the difference between the two modes when it comes to prove protection?
  - ii. Sketch what an IP packet looks like after IPSec protection in the two different modes. You only need to show payload and the different headers (not the individual header fields).
  - iii. Why can't AH all fields of an IP header be included in the AH's end-to-end integrity check? 3
- b) IKE (Internet Key Exchange) is a protocol for doing mutual authentication and establishing a shared secret key to create an IPsec security association (SA). 4
- i. What is the purpose with the Diffie-Hellman exchange in IKE phase 1?
  - ii. Why does IKE use cookies and nonces? 3
  - iii. Why are there two phases in IKE? 3
7. a) Kerberos is a protocol that is based around Needham-Schroeder protocol for many to many authentications. Now answer the following questions. (Use necessary diagrams to justify your answers) 5×3
- i. What is a Kerberos credential? What are credentials used for?
  - ii. What is the main idea behind the use of a TGT (Ticket Granting Ticket)?
  - iii. The information in a TGT (Ticket Granting Ticket) is encrypted so the client cannot access the information in the TGT. However, all information in the ticket is already known to the client. Why is it still necessary to encrypt it? 10
- b) Describe the cryptographic enhancements of Kerberos V5 over Kerberos V4.
8. a) Your company ABC LTD. is responsible of the security design of an online banking website (SECURE BANKING). The new system should allow every registered customer to check the status of their bank account and perform secure online bank transfers. Your company receives a set of requirements for the new design that can be summarized in five categories: 5×5
- i. Protection against denial of service (DoS) attack to the bank web server (Trusted Banking). (i.e. Trudy cannot overload the web server by sending multiple fake web requests)
  - ii. Strong authentication of the Bank's customers. (i.e. Trudy cannot impersonate Alice.)
  - iii. Privacy and integrity of the communications between the SECURE BANKING and the customer. (i.e. Trudy cannot read or modify the content of the communications between the Bank's server and Alice).

- iv. Strong authentication of the Bank's website (i.e. Trudy cannot impersonate the Bank's website. Alice is sure to be talking to the Bank).
- v. The bank can prove to the customer and to any other third party (e.g. tax authorities) that certain bank transfer has been performed in some given time. (i.e. Trudy cannot create a fake invoice. Strong accountability.)

In order to avoid money laundry, every year the bank sends to each customer and to the tax authorities a written summary of every bank transfer performed from the account.

Describe how your new system will work. Write how you will provide each of the five features in a different section/paragraph.

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**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 4753: Bioinformatics**

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

**There are 8 (eight) questions. Answer any 6 (six) of them.**

**Figures in the right margin indicate marks.**

1. a) Explain how transcriptions are controlled by *enhancer sites* and *promoter sites*. 10  
b) Compare locations of *enhancer sites* and *promoter site* with respect to associated gene within a genome. 5  
c) Discuss the functions of *silencer sites*. 5  
d) Write short notes on *sense* and *anti-sense* strand of dsDNA. 5
2. a) Align the following two sequences globally using Needleman-Wunsch algorithm with the parameters +2 for match, -2 for mismatch, and -1 for gap. 15  
  
Sequence 1: A G C T A A G C T A A  
Sequence 2: G C T T A A G T A A T  
  
b) Discuss InDel operation. Can InDel operation represents any point mutation? Explain your answer. 5  
c) Compare *Eukaryotic Cells* and *Prokaryotic Cells*. 5
3. a) Five organisms A, B, C, D, and E have a common gene Z in all of them to do similar functions. Distances between the genes within the organisms are presented in the Table 1. Use *Neighbor Joining* method to find phylogenetic tree for the organisms. 15

Table 1: Distance matrix

|   | A | B | C  | D  | E |
|---|---|---|----|----|---|
| A | - | 5 | 9  | 9  | 8 |
| B |   | - | 10 | 10 | 9 |
| C |   |   | -  | 8  | 7 |
| D |   |   |    | -  | 3 |
| E |   |   |    |    | - |

- b) Give definitions of the following phylogenetic trees: 10  
*scaled tree, unscaled tree, additive tree, rooted tree, unrooted tree.*
4. a) How data points are categorized in DBSCAN, a density-based clustering algorithm? Write down the DBSCAN algorithm. 3+7  
b) Among k-means and DBSCAN algorithms, which one yields better clustering? Justify your answer. 10  
c) '*Phylogenetic trees are usually bifurcating but it is also possible to have multifurcating trees*' – Explain this statement. 5

5. a) What is consensus string? Find the consensus string for the following sequences: 10
- GAGGC  
TCCAC  
TAGGC  
ACAGT
- Find the Position Probability Matrix (PPM) from the sequences.
- b) Explain projection algorithm for motif search. 10
- c) What are the importance of predicting secondary structure of protein? 5
6. a) What is RNA-Seq (RNA sequencing)? Write down the steps of RNA-Seq method and explain the first step. 10
- b) Explain various strategies during RNA isolation process for RNA-Seq. 10
- c) Write short note on FASTQ format. 5
7. a) A number of RNA-Seq experiments have been performed and outcome is presented in Table 2 below. Normalize the data using TPM method. 10

Table 2: RNA-Seq experimental data

| Genes         | Read Counts (lac) |        |       |
|---------------|-------------------|--------|-------|
|               | Expr 1            | Expr 2 | Expr3 |
| Gene A (4 KB) | 42                | 20     | 82    |
| Gene B (1 KB) | 9                 | 6      | 20    |
| Gene C (3KB)  | 32                | 15     | 62    |
| Gene D (2KB)  | 21                | 10     | 41    |

- b) Normalize the RNA-Seq experimental data shown in Table 1 using Quantile method. 10
- c) Explain why gene length normalization is essential for RNA-Seq experimental data. 5
8. a) What is GC-content? What is its significance in bioinformatics? 10
- b) Do the number of chromosomes or number of genes represent complexity or intellectuality of an organism? –Justify your answer. 10
- c) Write short notes on the followings:  
*dendrogram, heatmap* 5

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SEMESTER FINAL EXAMINATION

WINTER SEMESTER, 2018-2019

DURATION: 3 Hours

FULL MARKS: 150

**CSE 4773: Internetworking Protocols**

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

There are 8 (**eight**) questions. Answer any 6 (**six**) of them.

Figures in the right margin indicate marks.

1. a) How long does it take a packet of length 1,000 bytes to propagate over a link of distance 2,500 km, propagation speed  $2.5 \times 10^8$  m/s, and transmission rate 2 Mbps? Does this delay depend on transmission rate? 7
- b) What are the differences between routing and forwarding? 5
- c) What is the importance of finding the First Address of destination host when a packet arrives at the router from any source host? 6
- d) Define the *Access Networks* with a hierarchical classification. 7
  
2. a) What are *Datagram Networks* and *Virtual Circuit Networks*? Is the Internet a Datagram or Virtual Circuit Network? 5
- b) An organization is granted a block of addresses with the beginning address 14.24.74.0/24. 12  
The organization needs to have 3 subblocks of addresses to use in its three subnets as shown below:
  - i. One subblock of 120 addresses.
  - ii. One subblock of 60 addresses.
  - iii. One subblock of 10 addresses.
- c) How does a newly arriving host in a subnet get an IP address automatically? 5
- d) Describe the necessity of *Network Address Translation* (NAT). 3
  
3. a) Consider sending a 3300-byte datagram into a link that has an MTU of 800 bytes. Suppose the original datagram is stamped with the identification number 332. How many fragments are generated? What are the values in the various fields in the IP datagram(s) generated related to fragmentation? 12
- b) *Multicast Distance Vector Routing Protocol* (MDVRP) uses source-based trees, but any router never actually makes a routing table. When a router receives a multicast packet, it forwards the packet as though it is consulting a routing table. We can say that the shortest path tree is evanescent. After its use (after a packet is forwarded) the table is destroyed. To accomplish this, the multicast distance vector algorithm uses a process based on four decision-making strategies. Each strategy is built on its predecessor. Briefly explain each of the strategy one by one and show how each strategy can improve the shortcomings of the previous one. 13
  
4. a) What are the differences between *Message Confidentiality* and *Message Integrity*? 7

- b) List and briefly define categories of passive attacks and active security attacks. 6
- c) Describe how a *Botnet* can be created, and how it can be used for a *DDoS* attack. 7
- d) Draw a diagram illustrating the architecture of *Satellite Communication System*. 5
5. a) Consider the network shown in Figure 1, and assume that each node initially knows the costs to each of its neighbors. Consider the *Distance-Vector* algorithm and show the distance table entries at node z. 6
- 
- Figure 1: network for question 5 (a)
- b) Discuss how a hierarchical organization of the Internet has made it possible to scale to millions of users. 8
- c) Write short note on *Link-State Routing*. 6
- d) How is the *Expected Transmission Count* (ETX), a path metric for multi hop wireless network calculated? 5
6. a) A router D using *Routing Information Protocol* (RIP) has the routing table shown in table- 1. 12
- Table 1: Routing table for router D in question 6 (a)
- | Destination | Cost | Next Router |
|-------------|------|-------------|
| Net1        | 4    | B           |
| Net2        | 2    | C           |
| Net3        | 1    | F           |
| Net4        | 5    | G           |
- i. Show the RIP response message sent by this router.
- ii. Consider router D receives a RIP response message from router C, which is summarized as: (Net1, 2), (Net2, 1), (Net3, 3), (Net4, 7). Now, show the updated routing table for router D.
- b) How does the *Sensor-MAC* (SMAC) protocol improve the *Wireless Sensor Networks* (WSN) network performance? Describe the protocol with appropriate diagram(s). 9
- c) Describe the structure of a *Uniform Resource Locator* (URL). 4

7. a) In Figure 2, the reachability lists of router R1, R2, and R3 in path-vector routing are depicted. Draw the stabilized routing tables of each router considering each ASs has already shared their reachability list with each other.

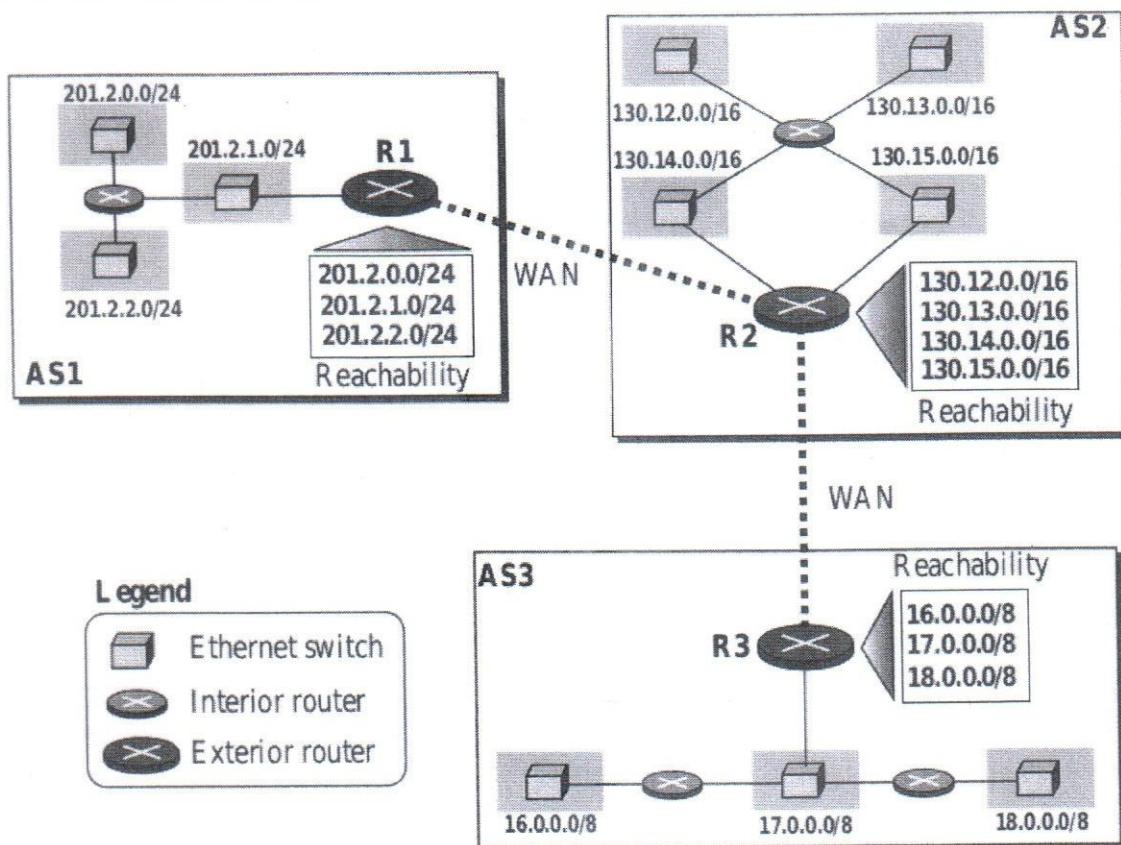


Figure 2: An example network

- b) Write short note on *Border Gateway Protocol* (BGP) update message. 8
- c) Consider an autonomous system named AS1, where RIP is utilized as its interior routing protocol. The routing table in a particular router R1 of AS1 has 20 entries. It does not receive information about five routers for 200s. How many RIP timers are running at this time? 8.5
8. a) Define *Routing Metric* with appropriate example. 5
- b) Mention few limitations of Satellite Communication System. 5
- c) Consider a *Basic Service Set* (BSS) of *Wireless Local Area Network* (WLAN) consists of three stations (A, B, and C) which are controlled by *Distributed Coordination Function* (DCF). 15

Draw a time line diagram representing the sequence of actions for a successful retransmission of a single *MAC Service Data Unit* (MSDU) from station-A to station-C. The diagram should depict the detail backoff procedure performed by every contending station. Consider the *minimum contention window* (CWmin) value is 4 (four). Note that, the x-axis of the diagram shows time and y-axis shows one horizontal line for each contending station.

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

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**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.**

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

1. a) Bioinformatics is one of the most impactful area of Data Mining. It is the science of storing, analyzing, and utilizing information from biological data such as sequences, molecules, gene expressions, and pathways. Though it is one of the promising areas, it comes with a lot of challenges. Outline the major research challenges of data mining in Bioinformatics. 15
- b) Outliers are often discarded as noise. However, one person's garbage could be another's treasure. For example, exceptions in credit card transactions can help us detect the fraudulent use of credit cards. Give two more examples where outlier information can be useful. 10
2. a) Most decision tree tools use gain ratio instead of information gain in their decision tree induction algorithm. Explain why? 5
- b) Table 1 contains the data from a mobile store "iMobile" in Boardbazar. Build a decision tree to classify the customer using *Gain Ratio* as the attribute selection measure. 20

Table 1: Customer Database of iMobile

| ID | Age     | Income | Region | Credit_rating | Buy Mobile |
|----|---------|--------|--------|---------------|------------|
| 1  | <20     | High   | USA    | Low           | No         |
| 2  | <20     | High   | USA    | High          | No         |
| 3  | 21...50 | High   | USA    | Low           | Yes        |
| 4  | >50     | Medium | USA    | Low           | Yes        |
| 5  | >50     | Low    | BD     | Low           | Yes        |
| 6  | >50     | Low    | BD     | High          | No         |
| 7  | 21...50 | Low    | BD     | High          | Yes        |
| 8  | <20     | Medium | USA    | Low           | No         |
| 9  | <20     | Low    | BD     | Low           | Yes        |
| 10 | >50     | Medium | BD     | Low           | Yes        |
| 11 | <20     | Medium | BD     | High          | Yes        |
| 12 | 21...50 | Medium | USA    | High          | Yes        |
| 13 | 21...50 | High   | BD     | Low           | Yes        |
| 14 | >50     | Medium | USA    | High          | No         |

3. Suppose that a data warehouse for Big\_University consists of the four dimensions: *student*, *course*, *semester*, and *instructor*, and two measures: *count* and *avg\_grade*. At the lowest conceptual level (e.g., for a given student, course, semester, and instructor combination), the *avg\_grade* measure stores the actual course grade of the student. At higher conceptual levels, *avg\_grade* stores the average grade for the given combination. 9
- a) Draw a snowflake schema diagram for the data warehouse. 8
- b) Starting with the base cuboid [student, course, semester, instructor], what specific OLAP operations (e.g., roll-up from semester to year) should you perform in order to list the average grade of CS courses for each Big University student? 8
- c) If each dimension has five levels (including all), such as "student < major < status < university < all", how many cuboids will this cube contain (including the base and apex cuboids)? 8

4. a) What is Metadata? What information should a metadata repository contain when used in a data warehouse? 10  
 b) Define *Dimension* and *Fact*. 5  
 c) Define OLAP and OLTP? Differentiate these two from the viewpoint of user, system orientation, data contents, DB design, view and access patterns. 10

5. a) What are the Data reduction strategies? Explain with appropriate examples. 10  
 b) Use these methods to normalize the following group of data: 15

235, 319, 400, 600, 1000

- min-max normalization by setting min = -1 and max = 7.
- z-score normalization
- z-score normalization using the mean absolute deviation instead of standard deviation normalization by decimal scaling

6. Market basket data of "iFashion" is listed in Table 2. Let min\_sup = 3 and min\_conf = 60%.

Table 2: Shopping data of iFashion

| Transaction | Items                                      |
|-------------|--------------------------------------------|
| t1          | {T-shirt, Trouser, Belt}                   |
| t2          | {T-shirt, Jacket}                          |
| t3          | {Jacket, Gloves}                           |
| t4          | {T-shirt, Trouser, Jacket}                 |
| t5          | {T-shirt, Trouser, Sneakers, Jacket, Belt} |
| t6          | {Trouser, Sneakers, Belt}                  |
| t7          | {T-shirt, Trouser, Belt, Sneakers}         |

- a) Find all the frequent itemsets using apriori algorithm. 18  
 b) List all the strong association rules (with support s and confidence c) matching the following meta rule, where X is a variable representing transactions, and Item denotes variables representing items (e.g., "Jacket," "Belt"):  
 $\forall x \in \text{Transactions}, \text{choose}(X, \text{Item}_1) \wedge \text{choose}(X, \text{Item}_2) \Rightarrow \text{choose}(X, \text{Item}_3) [s, c]$  7

7. a) Why is correlation important in finding strong association rule? Propose a method for finding correlation between two objects. 4+  
 b) Briefly discuss how researches in Data Mining can help in intrusion detection and prevention. 10  
 c) Briefly outline the complex data types used in recent mining applications. 7

8. Suppose a hospital tested the age and body fat data for 18 randomly selected adults with the result in Table 3:

Table 3: data for question 8

|      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|
| age  | 23   | 23   | 27   | 27   | 39   | 41   | 47   | 49   | 50   |
| %fat | 9.5  | 26.5 | 7.8  | 17.8 | 31.4 | 25.9 | 27.4 | 27.2 | 31.2 |
| age  | 52   | 54   | 54   | 56   | 57   | 58   | 58   | 60   | 61   |
| %fat | 34.6 | 42.5 | 28.8 | 33.4 | 30.2 | 34.1 | 32.9 | 41.2 | 35.7 |

- a) Draw the boxplots for age and %fat. 10  
 b) Briefly outline how to compute the dissimilarity between objects described by the following:  
  - Nominal attributes
  - Asymmetric binary attributes
  - Numeric attributes 3x 5

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

**SEMESTER FINAL EXAMINATION**

**DURATION: 3 Hours**

**WINTER SEMESTER, 2018-2019**

**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 8 (eight) questions. Answer any 6 (six) of them.**

Figures in the right margin indicate marks.

- |    |                                                                                                                                                                                                                                                                                                                                                                                                                                |              |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 1. | a) What are the key elements of an online program or course? Discuss any two of them.                                                                                                                                                                                                                                                                                                                                          | 10           |
| b) | You are appointed to facilitate an online course to teach <i>Computer Networks</i> . Discuss which form of ice breakers you might use in your course.                                                                                                                                                                                                                                                                          | 10           |
| c) | List common learning styles with brief description.                                                                                                                                                                                                                                                                                                                                                                            | 5            |
| 2. | a) Guest lectures have long been known to offer the possibility of enhancing student learning. Discuss how the virtual guest lecturer can enhance the quality of learning.                                                                                                                                                                                                                                                     | 10           |
| b) | What are the risk factors to bring guest lecturers in an online course? How those risks can be reduced?                                                                                                                                                                                                                                                                                                                        | 10           |
| c) | List some requirements that a guest lecturer should have for quality learning.                                                                                                                                                                                                                                                                                                                                                 | 5            |
| 3. | a) " <i>High quality learning can take place without going to a traditional classroom</i> " – Justify or deny this statement by giving arguments.                                                                                                                                                                                                                                                                              | 10           |
| b) | Write short notes on the followings:<br><br>MOODLE, MOOC, OCTR                                                                                                                                                                                                                                                                                                                                                                 | $3 \times 5$ |
| 4. | a) Online learning have both strengths and weaknesses. List the weaknesses of online learning. Discuss how these weaknesses can be reduced or eliminated.                                                                                                                                                                                                                                                                      | 15           |
| b) | The facilitator plays a vital role in developing and maintaining an online program that is effective, smooth, and that will support the realization of the planned learning outcomes. Discuss on some basic criteria for a person to be successful as an online facilitator.                                                                                                                                                   | 10           |
| 5. | a) Teaching online is time consuming as the absence of face-to-face contact with students requires instructors to respond to all inquiries in writing. An online teacher needs to define a clear time frame for responding to students within the different areas of online communication for a course.<br><br>Discuss on response time for each of these different areas.                                                     | 15           |
| b) | Web-based learning is well-suited for communications, collaboration, and information acquisition, but not for reading long text files. It is difficult to read screen after screen of text on a computer. In the Virtual Classroom, text-based lectures should be short and few.<br><br>Having the above discussion in mind list the different methods of information dissemination that can be used in an online environment. | 10           |
| 6. | a) Some researchers believe that not every student is "ideal" whether he is in a face-to-face or                                                                                                                                                                                                                                                                                                                               | 15           |

an online environment. Therefore, the online course facilitator is charged with the task of developing the skills of these non-ideal students while creating a learning environment suitable to various needs, preferences, and abilities. Discuss some methods that instructors can utilize to better facilitate their courses for every student in the class.

- b) List some instructional strategies which have been effectively used in the traditional classroom and can likewise be used in the online learning environment. Discuss any two of them. 10
- 7. a) A notable and well-accepted aspect in collaborative learning field is group support systems (GSS). What are the major features of GSS? Provide their description along with potential benefits in group communication. 12
- b) Compare the effect of group size in GSS and nonGSS based group work in light of recent study. 13
- 8. a) Students are needed much more support and feedback in the online environment than in a traditional course. Discuss some efficient strategies for providing feedback to the e-learners in Virtual Classroom. 13
- b) As a facilitator of an online course, it is important that you clearly communicate your expectations to your students. In your online course, you may provide tips for your students to use to help them be more successful online learners. Discuss some valuable tips that you might share with your students to be succeed as an e-learner. 12

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

**SEMESTER FINAL EXAMINATION**

**DURATION: 3 Hours**

**WINTER SEMESTER, 2018-2019**

**FULL MARKS:150**

**CSE 6197: Parallel and Distributed Computing**

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

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1. a) With examples explain various types of scalability problems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 12   |
| b) With the help of necessary figures, show how DNS name spaces are divided into zones.                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 8    |
| c) "Permanence cannot be guaranteed when a transaction has nested sub-transactions"- justify this statement.                                                                                                                                                                                                                                                                                                                                                                                                                                   | 5    |
| <br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |
| 2. a) Using the simplified organization of the internet search engine as an example, show the various levels of application layering.                                                                                                                                                                                                                                                                                                                                                                                                          | 12   |
| b) With the help of necessary figures, show the hierarchical organizations of nodes in a super-peer network.                                                                                                                                                                                                                                                                                                                                                                                                                                   | 8    |
| c) Write a short note on object based architectural style.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 5    |
| <br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |
| 3. a) How is transparency achieved in a remote procedure call (RPC)? Using the example of calling a remote function in a server, breakdown the steps involved in doing a remote computation through RPC.                                                                                                                                                                                                                                                                                                                                       | 6+12 |
| b) Show how data collection and information aggregation work in Astrolabe.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 7    |
| <br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |
| 4. a) Consider a jungle where there is possibility of wildfire during the summer. In many cases, when a fire originates in part of a jungle, it becomes too late before anyone can realize it and by the time people do, the fire has spread quite a bit. To ensure quick response, one alternative could be the usage of pervasive distributive systems. Give an idea of a sensor network that can be used to monitor wildfires and deploy quick response. You can draw any diagrams as necessary to demonstrate the workflow of your system. | 18   |
| b) What are the differences between a client stub and server stub?                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 7    |
| <br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |
| 5. a) With necessary figures, show the how the following procedures are handled in a two dimensional grid for Content Addressable Networks (CAN) <ul style="list-style-type: none"> <li>i. The mapping of data items onto nodes in CAN.</li> <li>ii. Splitting a region when a node joins.</li> </ul>                                                                                                                                                                                                                                          | 14   |
| b) Show the various types of organizations that exist in multi-tiered architectures.                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 11   |
| <br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |
| 6. a) How do you write a client and a server in a DCE RPC? Show with necessary figures.                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 16   |
| b) Consider a procedure <i>incr</i> with two integer parameters. The procedure adds one to each parameter. Now suppose that it is called with the same variable twice, for example, as <i>incr(i, i)</i> . If <i>i</i> is initially 0, what value will it have afterward if call-by-reference is used? How about if copy/restore is used?                                                                                                                                                                                                      | 5+4  |

7. a) Show the general organization of IBM's WebSphere Message Queuing System. 15  
b) Why is it sometimes so hard to hide the occurrence and recovery from failures in a distributed system? Why is it not always a good idea to aim at implementing the highest degree of transparency possible? 5+5
8. a) In many layered protocols, each layer has its own header. Surely it would be more efficient to have a single header at the front of each message with all the control in it than all these separate headers. Why is this not done? 6  
b) Describe the logical organization of a feedback control system. 14  
c) What is the role of middleware in a distributed system? Explain with an example 5

**Islamic University of Technology**

Organisation of Islamic Cooperation (OIC)

**Department of Computer Science and Engineering (CSE)****SEMESTER FINAL EXAMINATION**  
Duration: 3 Hours**WINTER SEMESTER, 2018-2019**  
Full Marks: 150**CSE 6249: Data Warehousing and Mining**

Programmable calculators are not allowed. Do not write anything on the question paper. There are 8(eight) questions. Answer any 6 (six) of them. Figures in the right margin indicate marks.

1. (a) What is data mining? In your answer, address the followings: [10]
    - i. Is it another hype?
    - ii. Is it a simple transformation of technology developed from databases, statistics, and machine learning?
  - (b) Present an example where data mining is crucial to the success of a business. What data mining functions does this business need? Can they be performed alternatively by data query processing or simple statistical analysis? [15]
  2. (a) With appropriate argument, derive the formula for proximity measures for binary attributes. You need to explain particularly why the formulas are slightly different for symmetric binary attributes and asymmetric binary attributes. Place suitable example data to establish your argument. [10]
  - (b) We can perform on-line analytical processing directly in an operational database instead of building a separate data warehouse. Present arguments to strengthen the statement. Also provide logics to weaken it. Finally justify your position. [5]
  - (c) What is bitmap index. Explain how it can be applied to OLAP data. [5]
  - (d) Information Gain is one of the most popular attributes selection measures. Mention the other two measures. Present the conceptual and formal definition of Information Gain. [5]
  3. (a) Euclidean, Manhattan and Minkowski distances have a major limitation. Briefly explain. Also explain how cosine similarity eliminates it. [5]
  - (b) Describe typical OLAP operations with diagrams. Assume any example you prefer. For each operation present the equivalent standard SQL statement based on your example. [10]
  - (c) What is a pure partition? There are three possibilities for partitioning tuples based on the splitting criterion. Briefly describe them with example. [10]
  4. (a) Explain the concept of Snowflake and Star schema with suitable example. Also highlight the strength and weakness of each model. [10]
  - (b) Suppose that a data warehouse for *Big University* consists of the four dimensions student, course, semester, and instructor, and two measures count and avg grade. At the lowest conceptual level (e.g., for a given student, course, semester, and instructor combination), the avg grade measure stores the actual course grade of the student. At higher conceptual levels, avg grade stores the average grade for the given combination. [15]
- Your tasks are:
- i. Draw a snowflake schema diagram for the data warehouse.
  - ii. Starting with the base cuboid [student, course, semester, instructor], what specific OLAP operations should you perform in order to list the average grade of CS courses for each Big University student.

- iii. If each dimension has five levels (including all ), such as  
`student < major < status <university < all` , how many cuboids will this cube contain (including the base and apex cuboids)?
5. (a) Define support and confidence with examples. Prove that confidence of rule  $A \Rightarrow B$  can be easily derived from the support counts of  $A$  and  $A \cup B$ . Place a suitable example to support the formula you have presented. [16]
- (b) Explain why mining frequent itemsets from a large data set is a challenging task. Also discuss how the concepts of *closed frequent itemset* and *maximal frequent itemset* can play role to overcome the difficulty. [10]
- (c) What is *antimonotonicity* property of Apriori algorithm? Explain with example. [5]
6. (a) Consider the following transactions: [15]

ACDFG  
ABCDF  
CDE  
ADF  
ACDEF  
BCDEFG

Assume minimum support count is 3 and minimum confidence is 75%. Now apply Apriori Algorithm to deduce:

- i. The representative sets
  - ii. The representative rules
- (b) How can we further improve the efficiency of Apriori-based mining? [10]
7. (a) Why is classification important in the area of data mining? Mention few real-life applications where classification is directly involved. Finally, outline the general approach to classification. [10]
- (b) Consider the class-labeled training tuples in Table 1. Now apply decision tree induction algorithm on this data set. You are required to show the formation of the first node (i.e. root) only. [15]

Table 1: Records for Question No. 7.(b)

| TID | age         | income | student | credit_rating | Class:buys PC |
|-----|-------------|--------|---------|---------------|---------------|
| 1   | youth       | high   | no      | fair          | no            |
| 2   | youth       | high   | no      | excellent     | no            |
| 3   | middle_aged | high   | no      | fair          | yes           |
| 4   | senior      | medium | no      | fair          | yes           |
| 5   | senior      | low    | yes     | fair          | yes           |
| 6   | senior      | low    | yes     | excellent     | no            |
| 7   | middle_aged | low    | yes     | excellent     | yes           |
| 8   | youth       | medium | no      | fair          | no            |

8. (a) What Is cluster analysis? Mention some applications of clustering. Briefly describe the requirements for cluster analysis. [10]
- (b) Explain the concept of k-Means clustering algorithm. *The k-means algorithm is sensitive to outliers-* Explain it with the aid of a suitable example. [15]
- (c) How can we modify the k-means algorithm to diminish its sensitivity to outliers? [5]

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**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**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.**

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 1. a) Memory recall and recognition are the two processes of information retrieval that can improve reminiscence to generate digital memory lane. Describe the uses of different memory cues in designing such digital memory lane considering human cognitive abilities.                                                                                                                                                                                                                                                                                                                                                                               | 12 |
| b) What are the implications of color in designing user interfaces for the color blinds? Explain with example.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 8  |
| c) Two symbols appear on the computer terminal. If the second symbol matches the first, the user presses "Yes" and presses "No" otherwise. What is the time between the second signal and response?                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 5  |
| 2. a) Consider the vertical scroll bar of a web browser or word processor. For each of Norman's five principles (Affordance, Constraints, Mapping, Visibility, Feedback), give one way that the scrollbar uses the principle for effective design. Describe the interface model of the scroll bar in one sentence.                                                                                                                                                                                                                                                                                                                                      | 12 |
| b) For the case study B in Question no. 7, list the usability and user experience goals with one sentence description for each goal. Perform a trade-off analysis between those two goals.                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 13 |
| 3. a) With examples explain how assumptions and claims are used to understand the problem space.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 7  |
| b) Identify, explain and discuss the components of a conceptual model using a web browser as an example.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 8  |
| c) Which conceptual model based activities is best for different types of applications?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 10 |
| <b>4. Case study A:</b><br>Interacting with smart-phones with one hand is often practiced in a variety of context - e.g. while traveling on trains, buses, carrying shopping carts, holding a baby and many more. Moreover, they are practiced among people with different hand-deformities. People with one hand, deformed hand and limited movement of hands often have problems to access the full screen of large screen smart-phones, especially when the navigation panel is presented at the top or extreme corners of the device. As an interaction designer, you have to design this one finger-based touch input system for the smart-phones. |    |
| a) Describe how you are going to identify the list of requirements of the system. Which data gathering technique will you follow? Give example.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 8  |
| b) Write at least two measurable usability requirements for each of the following usability goals:<br>i. Having good utility<br>ii. Effectiveness<br>iii. Efficient                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 10 |
| c) How will you represent those requirements to your teammates for analysis? Give example.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 7  |

5. a) Suppose you have to apply User-Centered Design (UCD) approach to the project described in the case study A of Question 4. Answer the followings:
- Define UCD.
  - Describe how you will follow each stage of the UCD approach.
- 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.
- c) What is usability engineering?
6. a) Using the data gathered in the Question 4, identify different kinds of requirements for interaction design (IxD).  
b) Write the persona(s) for the case study A of Question 4. Give reasons behind choosing the persona.  
c) Write one main scenario capturing how the user is expected to interact with the system.
7. **Case study B:**  
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 research and design a game therapy system for the children with DS to improve gross motor skills.
- Which prototyping technique will you follow? Explain why.
  - Construct a prototype for the system using the prototyping technique you have chosen in the previous Question 7.
  - Sketch out an experience map of your designed system.
8. a) What is experimental design? Identify the independent, dependent, random, control, and confounding variables to evaluate the system of case study A of Question 4. List the variables including proper justifications.  
b) Suppose you have to perform the cognitive walkthrough to evaluate your designed system as described in case study A of Question 4. Answer the followings:
- What are the usability attributes/test conditions/tasks that you will focus on the evaluation?
  - Who will be involved in the evaluation process? Explain.
  - How will you perform the cognitive walkthrough? Give example for any one of the selected tasks.

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**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION**

**WINTER SEMESTER, 2018-2019**

**DURATION: 3 Hours**

**FULL MARKS: 150**

**CSE 6391: Advanced Human Computer Interaction**

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

**There are 8 (eight) questions. Answer any 6 (six) of them.**

**Figures in the right margin indicate marks.**

1. a) Memory recall and recognition are the two processes of information retrieval that can improve reminiscence to generate digital memory lane. Describe the uses of different memory cues in designing such digital memory lane considering human cognitive abilities. 12
- b) What are the implications of color in designing user interfaces for the color blinds? Explain with example. 8
- c) Two symbols appear on the computer terminal. If the second symbol matches the first, the user presses “Yes” and presses “No” otherwise. What is the time between the second signal and response? 5
  
2. a) Consider the vertical scroll bar of a web browser or word processor. For each of Norman’s five principles (Affordance, Constraints, Mapping, Visibility, Feedback), give one way that the scrollbar uses the principle for effective design. Describe the interface model of the scroll bar in one sentence. 12
- b) For the case study B in Question no. 7, list the usability and user experience goals with one sentence description for each goal. Perform a trade-off analysis between those two goals. 13
  
3. a) With examples explain how assumptions and claims are used to understand the problem space. 7
- b) Identify, explain and discuss the components of a conceptual model using a web browser as an example. 8
- c) Which conceptual model based activities is best for different types of applications? 10
  
4. **Case study A:**  
Interacting with smart-phones with one hand is often practiced in a variety of context - e.g. while traveling on trains, buses, carrying shopping carts, holding a baby and many more. Moreover, they are practiced among people with different hand-deformities. People with one hand, deformed hand and limited movement of hands often have problems to access the full screen of large screen smart-phones, especially when the navigation panel is presented at the top or extreme corners of the device. As an interaction designer, you have to design this one finger-based touch input system for the smart-phones.
  - a) Describe how you are going to identify the list of requirements of the system. Which data gathering technique will you follow? Give example. 8
  - b) Write at least two measurable usability requirements for each of the following usability goals:
    - i. Having good utility
    - ii. Effectiveness
    - iii. Efficient
  - c) How will you represent those requirements to your teammates for analysis? Give example. 7

5. a) Suppose you have to apply User-Centered Design (UCD) approach to the project described in the case study A of Question 4. 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
6. a) Using the data gathered in the Question 4, identify different kinds of requirements for interaction design (IxD). 12
- b) Write the persona(s) for the case study A of Question 4. Give reasons behind choosing the persona. 8
- c) Write one main scenario capturing how the user is expected to interact with the system. 5
7. **Case study B:**  
 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 research and design a game therapy system for the children with DS to improve gross motor skills.
- a) Which prototyping technique will you follow? Explain why. 8
  - b) Construct a prototype for the system using the prototyping technique you have chosen in the previous Question 7. 10
  - c) Sketch out an experience map of your designed system. 7
8. a) What is experimental design? Identify the independent, dependent, random, control, and confounding variables to evaluate the system of case study A of Question 4. List the variables including proper justifications. 12
- b) Suppose you have to perform the cognitive walkthrough to evaluate your designed system as described in case study A of Question 4. Answer the followings:
- i. What are the usability attributes/test conditions/tasks that you will focus on the evaluation? 13
  - ii. Who will be involved in the evaluation process? Explain.
  - iii. How will you perform the cognitive walkthrough? Give example for any one of the selected tasks.