University of Dhaka
Department of Computer Science and Engineering
1st Year 2nd Semester Final Examination, 2021
CSE-1201: Fundamentals of Programming

Time: 3 Hours

Total Marks: 70

Answer any 5 (five) of the following questions

1. a) Assume, x = 11, y = 19 and z = 3. Find the value of x, y and z for each of the   4
        following cases. [each case runs independently]
        I.   z = 2*x + ++y
        II.   y = (x=x&y) | y - z
        III.   x = ~(z>>3) || (y<<4)
        IV.   (x+y)>>z ^ (y-z)<<x

    b) Write a program, that will take two integers A and B as input and find all the   5
        arithmetic results of (A op B). See examples for clarification.

Sample Input	Sample Output
12 7	+ = 19 - = 5 * = 84 / = 1 % = 5

    c) Assume that you have only one data type in your programming language which   5
        is int (8 bit signed integer). You need to write a program which will take two
        non-negative floating point numbers as input and add them. You may assume
        that in both the numbers, the part before decimal point will be less than or
        equal to 109. There will be exactly 2 digits after that decimal point in both
        numbers. While producing output, you can't print leading/trailing zeroes. See
        examples for clarification.

Sample Input	Sample Output
1.94 21.54	23.48
1.94 21.06	23

2. a) Write a program in C/C++ that takes an integer as input and prints 1 if the   5
        number can be expressed as a multiplication of two different prime numbers
        otherwise prints -1. See examples for clarification.

Sample Input	Sample Output
35	1
12	-1

    b) Consider two NxN matrices A and B. Write a program that takes N, A and B as   5
        input and prints the resultant matrix of AxB. See examples for clarification.

Sample Input	Sample Output
2 1 2 2 1 1 3 3 1	7 5 5 7

c) Write the content of the array a after each of the execution in line 2, 3, 4 and 5. 4

```
1 int a[] = {7,11,15,17,13},i;
2 for (i=0;i<5;i++) a[i]=a[i]*1;
3 for (i=0;i<5;i++) a[i]=a[((i+3<5)?i+3:0]-a[i]/2;
4 for (i=0;i<5 && (i&1);i++) a[i]=a[i]+a[i]*2;
5 for (i=0;i<5;i++) a[i]=a[i]-a[i]/2 ;
```

3. a) Write a program which will take an integer N and an array with N integers as 5
input. The program will also take another integer X as input and find the
summation of the values in the array which is greater than X and contains the
same set of prime divisors as X. See examples for clarification.

Sample Input	Sample Output
5 15 12 19 36 54 6	102

b) You will be given an array of even integers with N elements. You will need to 5
find the median of the array for each index I, considering the prefix of the array
till I. Your program will be evaluated based on it's efficiency. Note that median
of an array is the middle element (or average of the middle two elements in
case there are even number of elements) if the array is sorted. See examples
for clarification.

Sample Input	Sample Output
5 2 4 8 2 10	2 3 4 3 4

c) Write a comparative study between Array and Dynamic Array with dynamic 4
allocation methods in C/C++.

4. a) You will be given a string S. You need to add a minimum number of characters 5
at the end of S to make it a mirror palindrome. An even lengthed string is called
mirror palindrome if the string is mirrored at mid position e.g., abccba, deffed
etc. Your program will be evaluated based on its efficiency. See examples for
clarification.

Sample Input	Sample Output
abccb	1
abcd	4

b) Suppose you and your friends play an interesting game called "Read it reverse, if you can". In this game, every player have to read a document which is written in English but the words in each line are in reverse form. Write a program that reads a text file (in.txt) as input and write down the lines in another text file (out.txt) after fixing the lines. See examples for clarification.

5

Sample Input (in.txt)	Sample Output (out.txt)
I nac od ti	I can do it
uoy era eht tseb	you are the best

c) Write a program that takes a string of ASCII characters and finds the third recurring unique character in it. Note that you are not allowed to use nested loop or recursive function in your solution for this problem. Print -1 if there is no answer. See examples for clarifications.

4

Sample Input	Sample Output
abcdefababcd	c
abcdefabab	-1

5. a) Explain functions C/C++? Compare these functions with the arithmetic functions. Give proper examples.

3

b) Define the following functions with appropriate return type and relevant bodies:
• findMinIndex(int a[], int st, int ed): this function returns the index of a[] which has the minimum value between the indices st and ed (inclusive).
• sort(int a[]): this function sorts the array a[], using the function findMinIndex().

6

c) Write a function which will generate all the combinations if R (R<=N) integers are taken from the set consisting of all the integers from 1 to N. You will be given the input of N and R. See examples for clarification. See examples for clarification.

5

Sample Input	Sample Output
5 3	1 2 3
	1 2 4
	1 2 5
	1 3 4
	1 3 5
	1 4 5
	2 3 4
	2 3 5
	2 4 5
	3 4 5

6. a) Trace output for the following code. Use the memory snapshot given below.

```c
#include <stdio.h>
int main()
{
    int a = 105, b = 247;
    int *pa, *pb;
    pa = &a;
    pb = &b;
    printf("%u %d\n",pa, *pa);
    printf("%u %d\n",pb, *pb);
    int **ppa, **ppb;
    ppa = &pa;
    ppb = &pb;
    printf("%u %u %d\n",ppa, *ppa, **ppa);
    printf("%u %u %d\n",ppb, *ppb, **ppb);
    **ppa = *pb;
    *pa = **ppb;
    printf("%d %d %d %d\n",a,b,*pa,*pb,**ppa, **ppb);
    return 0;
}
```

Mem Loc.	value	Mem Loc.	value	Mem Loc.	value	Mem Loc.	value	Mem Loc.	value
100	a	108	pa	116	ppa	124		132	
101		109		117		125		133	
102		110		118		126		134	
103		111		119		127		135	
104	b	112	pb	120	ppb	128		136	
105		113		121		129		137	
106		114		122		130		138	
107		115		123		131		139	

b) A printer stores all of its incoming print jobs in a queue designed using a linked list. Each print job contains a print job id, a file (for simplicity, assume the file to be a text file) to print, how many copies to print and whether the print will be both sided or one sided. Each file has a name, page size (A4 or legal) and text content. The printer supports three functions

   i. Add a new print job to the queue.

   ii. Print the oldest job in the queue.

   iii. Abort a particular print job (delete with print job id from any arbitrary location in the linked list)

Your task is to design appropriate structures to hold file and print job properties as mentioned above and write necessary codes to perform operation i, ii and iii.

8

c) A grocery shop wants to go online e-commerce and that's why they need to design a structure to hold all required information about that product. They asked for your help. Your job is to design a suitable structure keeping all the information necessary about a product for the customer and write one user-defined function to take input as the structure and another to print from the structure.

Note: Which information to keep in structure is upto your imagination. Use your online shopping experience if you have any.

3

7. a) You are given a text file path as input. Your task is to write a program that can read the file and find the most frequent word in that file. In case of a tie, print the longest word (the word having the most number of characters). Further ties should be broken by choosing a lexicographically smaller one as output.

Note: words contain only English characters [A-Za-z]

6

b) An electric power distribution company charges its domestic consumer as follows:

Consumption Units   Rate of Charge

0-200   7 per unit
201-400   BDT 1200 plus BDT 6 per unit excess of 200
401-600   BDT 2300 plus BDT 5.5 per unit excess of 400
601- above   BDT 3200 plus Rs 4.7 per unit excess of 600

Given the consumption unit of such a domestic consumer, write a program that can calculate her/his electricity bill.

4

c) Write a code in C that will take two numbers X and Y as inputs. Then it will print the square of X and increment (if X<Y) or decrement (if X>Y) X by 1, until X reaches Y. If and when X is equal to Y, the program prints "Reached!"

4

Sample input(X,Y)	Sample output
10 5	100, 81, 64, 49, 36, Reached!
5 10	25, 36, 49, 64, 81, Reached!
10 10	Reached!

University of Dhaka
Department of Computer Science and Engineering
1st Year 2nd Semester B.Sc. Examination, 2021
EEE – 1202: Digital Logic Design

Total Marks: 70   Time: 3 Hours
(Answer any 5 (Five) of the following Questions)

1. a) Add and multiply the following numbers in the given base without converting to decimal: 6
        i) $(435)_8$ and $(152)_8$
        ii) $(730.5)_{12}$ and $(65)_{12}$

   b) How many bits are required to represent the decimal numbers in the range from 0 to 999   5
using straight code? Using BCD code?

   c) If the digital circuits in a computer only respond to binary numbers, why are BCD code   3
and hexadecimal numbers used extensively by computer scientists.

2. a) Express the Boolean function $f(x, y, z) = xy \vee \bar{x}z$ as a product of maxterms.   2

   b) Prove or give a counter example   4
        i) $AB = BC \Rightarrow A=C$
        ii) $A \vee B = A \vee C \Rightarrow B = C$

   c) Realize the function $f(A, B, C, D) = A(B \vee CD) \vee B\bar{C}$ using minimum number of NAND   4
gates only.

   d) Minimize the following Boolean expressions to the required number of literals: 4
        i) $BC \vee A\bar{C} \vee AB \vee BCD$ to four literals
        ii) $ABC \vee \bar{A}\,\bar{B}C \vee \bar{A}BC \vee \bar{A}\,\bar{B}\,\bar{C}$ to five literals.

3. a) Construct a MOD-6 counter circuit. How do you convert MOD-6 counter into MOD-5   5
counter? Explain it with the help of a circuit.

   b) Draw the circuit diagram to combine two 16×4 RAM chips to a 32×4 memory.   6

   c) Explain the characteristics of MOS over TTL. Briefly discuss the working principle CMOS   3
driving TTL circuit.

4. a) What is trigger? Distinguish between latch and edge-triggered flip-flop.   3

   b) Realize D-latch using S-R latch. How is it different from D flip-flop and explain its   6
working principle. Draw the circuit of D flip-flop using NAND gates.

   c) What is T flip-flop? Convert a J-K flip-flop into a T flip-flop.   5

5. a) Define a multi-output function. Explain the advantages of a multi-output function over a   5
single-output function. Discuss the reduction rules of Binary Decision Diagrams using
examples.

   b) Describe different representations of a multi-output function. Explain the construction   4
procedure of a compact MTBDD for a multi-output function.

c) Calculate the time complexities and the upper bounds on the number of nodes of SBDD, MTBDD and BDD and prove them, where n is the number of input variables and m is the number of functions.   5

6. a) State static and dynamic RAM.   2

   d) Design a digital system with 5-bit binary number as input. Your logic circuit displays the total number of 1's present in the input. Hence, if the input is 11111, the output will be 5 and if the input is 00000, then the output will be 0. Draw the truth table and represent the output functions of your logic circuit.   7

   c) Illustrate how you can design a BCD-to-7 segment driver.   5

7. a) Describe the design construction of a 5 × 32 decoder. You should show all necessary steps of construction.   6

   b) Design a 5-bit priority encoder with truth table. Define the logic equations for its output.   6

   c) Show a 4-bit shift register with the input *sin*, enable *en*, clock *clk*, and output *sout*.   2

University of Dhaka
Department of Computer Science and Engineering
1st Year 2nd Semester B.Sc. Final Examination, 2021
PHY-1203: Physics

Total Marks: 70   Time: 3 Hours

(Answer any 5 (Five) of the following Questions)

1. a) During a quasi-static, adiabatic expansion or compression, the pressure and volume of an   4
ideal gas obey the relationship $PV^Y = K$, a constant. Show that the work done on the
system in expanding from an initial state (P_i, V_i) to a final state (P_f, V_f) is given by:

$$W = -\frac{P_i V_i}{\gamma - 1}\left[1 - \left(\frac{P_f}{P_i}\right)^{(\gamma-1)/\gamma}\right]$$

b) Show that for an ideal gas, $C_P - C_V = R$, where the symbols have their usual meanings.   3

c) During an adiabatic process an amount of an ideal does 100 J of work and its temperature   2
decreases by 7.5 K. During another process it does 25 J of work and its temperature
decreases by 7.5 K. What is the heat capacity of the gas for the second process?

d) At an initial temperature the rms speed of nitrogen molecules is v_0. Suppose the   2
temperature of nitrogen gas is tripled and the N_2 molecules dissociate into atom. What
will be the rms speed of atoms?

e) At which temperature the rms speed of oxygen exceeds the average speed of oxygen   2
by 100 m/s? Given that the gram molecular mass of oxygen is 32 g.

f) As the volume of an ideal gas is increased at constant pressure, what happens to the   1
average molecular speed?

2. a) Using the kinetic theory of gases, find an expression for pressure exerted by an ideal gas   4
on the wall of a vessel.

b) Derive the formula for the mean free path of a gas molecule in a gas. How does it depend   4+1
on absolute temperature?

c) The air in your room is made up mostly of nitrogen and oxygen. Approximate these
molecules as spheres of radius $r = 1.00 \times 10^{-10}$ m.

i) Estimate the average distance between the air molecules in your room. Compare your   2+1
answer to the size of a molecule.

ii) Compare the average separation with the mean free path of the molecules.   2

3. a) One mole of a gas obeys the van der Walls equation of state: 5

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT,$$

And its molar internal energy is given by

$$U = cT - \frac{a}{V}$$

Where a, b, c and R are constants. Calculate the molar heat capacities C_p and C_v.

b) The thermal efficiency of a general heat engine is 35 percent, and it produces 60 hp. At   5
what rate is heat transferred to this engine in KJ/s?

c) Calculate the entropy change that occurs when 2.0 kg of water at 20.0 °C is mixed with   4
1.0 kg of water at 70.0 °C

4. a) Show that the reciprocal of a reciprocal lattice is a direct lattice. 4

   b) Titanium (T) has an HCP crystal structure with a density of 4.51 g/cm^3. If titanium has atomic weight 47.9 g/mol, 5

   i) What is the volume of its unit cell in cubic meters?

   ii) If the c/a ratio is 1.58, compute the value of c and a.

   c) Obtain the formula for interplanar spacing, d_{hkl}, of a cubic crystal structure and hence show that $d_{010} > d_{111}$. (Here h, k, l are miller indices) 5

5. a) Show that for simple harmonic oscillator, the sum of the kinetic energy and the potential energy is a constant. Draw the plots of the kinetic and potential energies with respect to time within one period of oscillation. 2+2

   b) Set up the differential equation of wave motion for a transverse wave propagating on a stretched string in the form: $\frac{\partial^2 y}{\partial x^2} = \left(\frac{1}{v^2}\right)\frac{\partial^2 y}{\partial xt^2}$. Solve the equation and show that the general solution is a linear combination of a forward going and a backward going wave. 3+4

   c) What happens when a stretched string has one end attached to a transverse vibrator and the other end (i) strongly attached to a rigid body and (ii) loosely attached to a light hoop that can move without friction on a pole? Explain your answer. 1.5+ 1.5

6. a) What are the conditions of interference of light? 2

   b) In Young's double-slit experiment, find the number of bright fringes per unit width on the screen. Given that d = center-to-center slit-spacing, D = perpendicular distance from the slits to the screen, a = slit width of both the slits and λ = wavelength of light. 3

   c) In the Newton's ring experiment, the thickness of the airfilm is $t = t(r)$. Prove that: 5

   i) Diameters of bright rings are proportional to square roots of odd numbers.

   ii) Diameters of dark rings are proportional to square roots of natural numbers.

   d) Calculate the minimum thickness of a soap-bubble film that results in constructive interference in the reflected light if the film is illuminated with light whose wavelength in free space is λ =600 nm. 2

   e) Find an expression of the Brewster angle in terms of the refractive index of the denser medium with respect to the lighter medium. 2

7. a) Derive an expression for the intensity distribution of a single-slit and hence find the positions of minima and maxima. 5+1 +2

   b) In a double slit diffraction pattern, the width of the slits is a = 0.0088 cm and the slit-separation is d = 0.035 cm. The wavelength of light used is λ = 6.328 × 10^{-5} cm. Find the first missing order. 2

   c) Consider the second minimum adjacent to the central maximum in a single-slit diffraction pattern. Let a be the slit-width. A ray coming to this point from the top edge of the slit is 180° out of phase with a ray coming from another point inside the slit. How far away from the top edge is the second point? 2

   d) Light of wavelength 600 nm is incident on a slit of width 0.01 mm. A diffraction pattern is formed on a wall 5 m away from the slit. What is the width of the central maximum? 2

University of Dhaka
Department of Computer Science and Engineering
1st Year 2nd Semester B.Sc. Final Examination, 2021
MATH-1204: Methods of Integration, Differential Equations and Series

Total Marks: 70   Time: 3 Hours

(Answer any 5 (Five) of the following Questions)

1. a) Find an actual explicit solution to $y' = \frac{t}{y}, y(2) = -1$.   3

   b) Given that every solution of $\frac{dx}{dy} + y = 2xe^{-x}$ may be written in the form $y =$ 5
   $(x^2 + c)e^{-x}$, for some arbitrary constant c, solve the following initial value problem:

   $$\frac{dx}{dy} + y = 2xe^{-x}, y(-1) = e + 3$$

   c) What is Exact Differential Equation? How can we make a non-exact differential equation   2+2
   exact? Can we do that always?   +2

2. Solve the following differential equations: 3.5
                                                                                                    x 4
   a) $v^3 du + (u^3 - uv^2)dv = 0$

   b) $8\cos^2 y dx + \cosec^2 x dy = 0, y(\frac{\pi}{4}) = \frac{\pi}{4}$

   c) $(x^2 + 1)\frac{dy}{dx} + 4xy = x$

   d) $(2(\sqrt{xy}) - y)dx - xdy = 0$

3. a) Evaluate the integral below: 4

   $$\int_{-\infty}^{\infty} \frac{1}{1 + x^2} dx$$

   b) Find the area enclosed by the ellipse   5

   $$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

   c) Evaluate: 5

   $$\int \frac{2x^2 - x + 4}{x^3 + 4x} dx$$

4. a) Determine whether the integral is convergent or divergent.   4

   $$\int_0^{\infty} \frac{dx}{\sqrt[3]{1 + x}}$$

   b) For $x = 3t + 2, y = 2t + 3$ 4+2

   i. Sketch the curve by using the parametric equations to plot points. Indicate with an
   arrow the direction in which the curve is traced as t increases.

   ii. Eliminate the parameter to find a Cartesian equation of the curve.

   c) Find the tangent to the cycloid $x = r(\theta - \sin x), y = r(1 - \cos x)$ at the point where   4
   $x = \frac{\pi}{3}$.

5. a) Sketch the curve with polar equation $r = 2\cos\theta$. Also find a cartesian equation for this **3+2**
curve.

b) For the cardioid $r = 1 + \sin\theta$, find the points on the cardioid where the tangent line is **5**
horizontal or vertical.

c) Determine whether the series $\sum_{n=1}^{\infty} \frac{\ln n}{n}$ converges or diverges. **4**

6. a) Find the radius of convergence and interval of convergence of the series **6**

$$\sum_{n=0}^{\infty} \frac{n(x+2)^n}{3^{n+1}}$$

b) Find a power series representation for $\ln(1+x)$ and its radius of convergence. **4**

c) Show that the harmonic series is divergent **4**

$$\sum_{n=1}^{\infty} \frac{1}{n} = 1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \ldots\ldots\ldots$$

7. a) What is the difference between the Taylor series and Maclaurin Series? Find the **2+3**
Maclaurin series of the function $f(x) = e^x$ and its radius of convergence.

b) Test whether the following series is convergent or not: **4**

$$\sum_{n=1}^{\infty} \frac{1}{n^3} = \frac{1}{1^3} + \frac{1}{2^3} + \frac{1}{3^3} + \frac{1}{4^3} + \cdots$$

c) Find the Maclaurin series for $sinx$ and prove that it represents $sinx$ for all x. **5**