University of Dhaka
Department of Computer Science and Engineering
1st Year 2nd Semester B.Sc. Final Examination, 2020
PHY-1203: Physics

Total Marks: 70

Time: 2 Hours

(Answer any 3 (Three) of the following Questions)

1.
a) State and explain zeroth, first and the second laws of thermodynamics. 3+3+3

b) During an adiabatic process an amount of an ideal gas does 100 J of work and its temperature decreases by 5 K. During another process it does 25 J of work and its temperature decreases by 5 K. What is the heat capacity of the gas for the second process? 3

c) The initial volume of a sample of an ideal gas is V. Its pressure is doubled during a process in which the energy given up as heat by the gas equals the work done on the gas. Find the final volume. 3

d) Calculate the change of entropy of an ideal gas undergoing adiabatic free expansion inside an insulated container from an initial volume V_i to a final volume $V_f = 2V_i$. 4

e) Using diagrams of a heat engine and a refrigerator, prove the equivalence of the Kelvin-Planck and Clasius statements of the second law of thermodynamics. 4.33

2.
a) Using the Maxwell-Boltzmann speed distribution formula derive the energy distribution formula assuming only kinetic energy as the internal energy of an ideal gas. 3

b) Derive the mean energy, the most probable energy and the RMS energy of an ideal gas in thermal equilibrium at temperature T. 3+3+3

[You may find the following integrals useful:

$$\int_0^\infty u^{3/2}e^{-u}du = (3/4)\sqrt{\pi}, \int_0^\infty u^{5/2}e^{-u}du = (15/8)\sqrt{\pi}]$$

$$\lambda = \frac{1}{\sqrt{2}\pi d^2 \ell}$$

$$\frac{1}{2}mv^2 =$$

c) Using the kinetic theory of gases, find an expression for the mean-free path of the gas. 6

d) Certain Ideal gas is found to be obey $PV^{5/3} = Constant$ during an adiabatic process. Such a gas at initial temperature T is adiabatically compressed to half the initial volume. Its mean free path was initially λ. What will be the changed mean free path? 3

e) What would be the most probable velocity for one Oxygen molecule at 300 K? 2.33

3.
a) Prove that the volume of a Bravais lattice primitive cell is, $V = |a_1.(a_2 \times a_3)|$ where the a_i are three primitive vectors. And the volume of the primitive cell of the reciprocal cell is, $\frac{(2\pi)^3}{V}$ 6.33

b) Three lattice vectors in a unit cell are given by : $\vec{a} = a\hat{x}, \vec{b} = b\hat{y}, \vec{c} = c\hat{z}$ with $a \neq b \neq c$. 2+2

    i. How many lattice points per unit cell are there in this crystal? Prove.

    ii. What are the symmetry elements (mirror planes/axes of n-fold symmetry) for this system? Explain with figure.

c) Draw $(\bar{1}11)(1\bar{2}1)$ and $(\bar{2}10)$ planes in a cubic lattice. 3

d) Show that the reciprocal lattice translational vector $(\vec{G}_{hkl})$ is perpendicular to the crystalline plane (hkl) 5

e) What is the coordination number for the hexagonal close-packed crystal structure? Explain how do you determine the coordination number for hexagonal crystal. 2.5+2.5

4. a) Explain how two simple harmonic vibrations acting simultaneously on a particle and in perpendicular directions can be compounded. Deduce an expression for the resultant vibration. 5

b) Explain damped harmonic oscillations. Write down its differential equation and mention the special cases of damping. (diagram preferred) 5

c) Find the frequency of the combined motion of each of the following: 3+3

(i) $\sin\left(2\pi t - \sqrt{2}\right) + \cos(2\pi t)$ (ii) $\sin(3t) - \cos(\pi t)$

d) Construct the Lissajous figures for the following motions: 2+2

(i) $x = \cos 2\omega t$, $y = \cos\left(2\omega t - \dfrac{\pi}{4}\right)$ (ii) $x = \cos 2\omega t$, $y = \sin 2\omega t$

e) A 200-g pendulum bob is oscillating with Amplitude = 3 cm, and f = 0.5 Hz. How much KE will it have as it passes through the origin? 3.33

5. a) Two sinusoidal waves of the same type in the same medium having the same frequency but of two different amplitudes and two phase angles are subtracted. Find the equation of the resultant wave and comment on its nature. 4

b) Derive the following relation between the diameter of a Newton's ring and the wavelength of light in Newton's ring experiment (draw appropriate figure): 7

$$\lambda = \frac{D_{n+m}^2 - D_n^2}{4mR}$$

c) Consider the second minimum adjacent to the central maximum in a single-slit diffraction pattern. The ray coming to this point from the top edge of the slit is 180° out of phase with another ray coming from another point. Find the position of the second point with respect to the first inside the slit. Draw a clear figure showing all the relevant rays in solving the problem. 4

d) Explain Brewster angle and find an expression for the Brewster angle in terms of the refractive index of the denser medium with respect to the lighter medium. 2+3

e) An unpolarized beam of light with intensity I_0 is incident on an ideal polarizing sheet and passes through onto another ideal polarizing sheet. The axes of polarization of the two plane polarizer makes an angle of ϕ with each other. The intensity of the emerging light from the last polarizer is $I_0/4$. Find the angle ϕ. 3.33
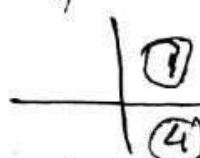
Total Marks: 70   Time: 2 Hours

(Answer any 3 (Three) of the following Questions)

1. a) What do you mean by BCD code? What are the differences between BCD and straight binary number representation? Explain using example.   4

   b) Briefly explain the operation of a Full-adder with truth table, logical expression and circuit.   6

   c) What is full subtraction? How does it differ from half subtraction? Explain the operation of a 4-bit 2's complements adder/subtraction circuit using control input that selects add or subtraction input.   10

   d) Describe the relative advantages and disadvantages of n-bit serial adder and n-bit parallel adder. Describe how carry propagation delay effects on the performance of the n-bit parallel adder.   3.33

2. a) What are universals gates? Draw the equivalent circuit of Exclusive-OR and Exclusive-NOR gates using NAND gates.   6

   b) Briefly explain DeMorgan's theorems those are extremely useful in simplifying expressions in which a product or sum of variables is inverted.   4.33

   c) Write the logical expression for the following truth tables, simplify it Boolean algebra or DeMorgan's theorems and finally draw the corresponding logical circuit.   7
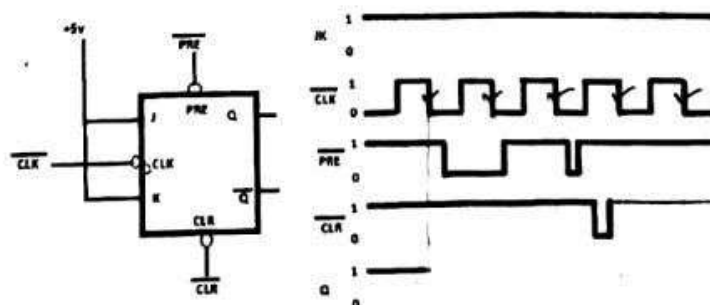

A	B	C	Z
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

   d) What is Karnaugh Map? Use Karnaugh Map to simplify following expression: 6

   $$Z = \bar{A}\,\bar{B}\,\bar{C}\,\bar{D} + CD + A\bar{B}C + \bar{D}$$

3. a) Mention the difference between a latch and a Flipflop (FF).   3.33

   b) Determine the Q waveform for the J-K FF with the input given below. Assume the clock is negative edge triggered and initial value of Q = 1.   7

Total Marks: 70

Time: 2 Hours

(Answer any 3 (Three) of the following Questions)

1. a) Find the output for the given code segment: 8

```
#define S 1000
#define maxi(x, y) x > y ? x : y

int main(){
    int x1 = 25;
    int x2 = 15;
    int y1 = 64;
    int y2 = 13;

    printf("1: %d %d\n", x1, x2);
    printf("2: %d %d\n", x1&x2, !x2);
    if (y1 & x2 > x1 | y2)
        printf("3: %d %d\n", y1, y2=maxi(y1++, x1&y1));
    else
        printf("4: %d %d\n", y2, y1=maxi(y2++, x2&y2));

    printf("5: %d %d %d %d\n", x1, x2, y1, y2);
    for (int i=x1; i<x2; i+=y1){
        y2 = x1&x2 | y1 ;
    }

    printf("6: %d %d %d %d\n", x1, x2, y1, y2);

    return 0;
}
```

b) Write a C/C++ program to find all the roots of the following equation. 8
   $ax^2+bx+c = 0$; here a, b, c, are constants.
   Note that you have to indicate all the possible cases in your program.

c) Suppose, you have 10MB storage in your RAM. You have to sort an array of size 7.33
   100MB. Indicate whether it is possible using each of the following sorting algorithms
   or not with proper reasoning.
   i) Bubble Sort
   ii) Counting Sort
   iii) Merge Sort

2. a) Write the function body for : *seqPosition(line, sequence) {... }* 8
   Here, the function *seqPosition* prints all the positions *s* in *line* where the suffix of *line*,
   index starts from *s* contains *sequence* as a subsequence. See the sample input and
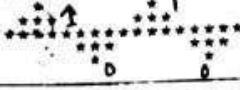   output for better understanding.
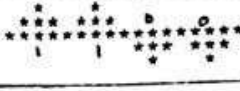
Sample input	Sample output
This is a test ¹¹ ²³ ⁴ʰⁱˢ ᵗᵉˢᵗ is	2 5
This is a test ¹ʰⁱˢ ˢᵉˡᵉᶜᵗᵉᵈ st	3 6 12

b) Write the function body for : *wave(pattern){ ... }* 8
   Here, the function *wave* takes an input *pattern* as a binary string and print the wave
   form using necessary asterisk (*) for the given pattern. Each character in the *pattern*
   represents whether the corresponding half-wave (Example waves are sound wave, light
   wave etc.) is positive or negative. See the sample input and output for better
   understanding.

c) How can we operate an edge triggered D FF in toggle mode? 7

d) Can we use half adder to implement a full adder? If yes, design a full adder using half adder for single bit sum. If your answer is no, state why not? 6

4. a) What does a MUX do? Explain the operation of a MUX with proper circuit and truth tables that has 8 inputs. 5.33

b) What is a seven segment display? Briefly explain the operation of BCD to seven segment decoder driver to drive a seven segment LED display for a particular digit. 10

c) Why DAC and ADC conversion are required in real world application? Briefly explain the operation of a digital-ramp type ADC with proper diagram. 8

5. a) Draw the block diagram of a RAM architecture. 4

b) Distinguish between SRAM and DRAM. 6

c) If we want to expand word size of 2Kx8 PROM to 2KX16, how many PROM chips are required and how many address lines are required? 6.33

d) Briefly explain the operation of a synchronous decade counter with example of sequences. 7

Sample Input	Sample Output
1010	
1100	

c) Complete the following structure with necessary definition according to the instructions.   **7.33**

Struct Matrix {

    int value[10][10];

    void rotat_clock () { ... }
    void rotat_anticlock () { ... }
    void multiply (struct Matrix B) { ... }
    void print_diagonal () { ... }

};

Instructions:,

    i) *rotate_clock*: rotates the matrix clockwise
    ii) *rotate_anticlock*: rotate the matrix anticlockwise
    iii) *multiply*: multiply the matrix with argument matrix B and update the corresponding values. Note that it is assumed that all the considered matrices will be square matrices.
    iv) *print_diagonal*: It prints the main diagonal of the matrix.
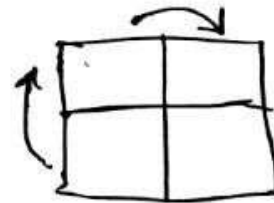
3. a) Write a code in C that will take two numbers X and Y as inputs. Then it will print the square of X and increment (if X<Y) or decrement (if X>Y) X by 1, until X reaches Y. If and when X is equal to Y, the program prints "Reached!"   **5.33**

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!

b) Suppose your friend Ahmed is a job holder whose monthly salary is divided into three sections: basic, house rent and medical allowance. Each year he asks for your help to calculate his tax. So, this year you have decided to build a console application for him so that he does not need others help later on. Now write a C program to calculate income tax of an individual with following conditions: **10**

- Basic monthly payment is entirely taxable income.
- House rent upto 50% of basic payment will not be added to taxable income.
- Medical allowance upto BDT 60,000 **yearly** is free of tax.

And tax calculation rules on **annual taxable income** are:

Annual Taxable Income	Tax Rate
First 0 to 2,50,000 Taka	0%
Next (up to) 4,00,000 Taka	10%
Next (up to) 5,00,000 Taka	15%
Next (up to) 6,00,000 Taka	20%
Next (up to) 30,00,000 Taka	25%
Rest of the income	30%

Input:
You will be given **monthly** income of an individual divided into basic, house rent and medical allowance category.

Output:
Calculate annual taxable income and estimated tax.

Sample Input	Sample Output
Basic: 25000 House Rent: 18000 Medical: 6000	Taxable Income breakdown: Basic: 300000 House Rent: 66000 Medical: 12000 Annual Taxable Income: 378000 Tax: 12800 Taka

c) Write a function *swapBody()* which takes two equal length strings as input and swap all the even indexed characters between them. See the sample input and output for better understanding. **8**

Sample input	Sample output
I am, a student	dm 'aos.u.eut
I am not a bus	I amₙn ttadbns

not-a-bus

4. a) Show the function blocks as well as variable status after executing each line of code for the given code segment: **10**

```
int go (int x) {
    while (x<100) {
        printf("%d\n", x);
        x |= ((x<<2) + 1);
    } retunn x;
void foo (int x, int *y) {
        *y = go (x) ;
        printf("%d %d\n", x, *y);
}

int main() {
    int a =3;
    int b = 11;
    int c = 37;
    int d;

    printf("%d %d %d\n", a, b, c);
    foo (b, &d);
    printf("%d %d %d %d\n", a, b, c, d);
    return 0;
}
```

b) Point out the errors in the given code segment with possible corrections. **8**

```
int bar (int x, int y) {
    while (x < y) {
        y += bar (y, y % x);
    }
    return x;
}
int main(void) {
    int x = 2341;
    int y = 234, z;

    printf("%d %d %d\n", x, y, z);
    int c = x = y*y + x;
    printf("%d %d %d\n", c, x, y);
    y = z = bar (z, x);
    printf("%d %d \n", go (c, x) + c, y);
    return 0;
}

int go (int a, int b) {
    a&b ? return a: return b;
}
```

c) Write a program to define a vector (Dynamic Array). Your implemented vector should have the following properties: **5.33**
   i) Values could be accessed through index directly
   ii) Vector can resize itself whenever needed

5. a) Identify and explain all syntax errors in the following C code.

```
#INCLUDE<stdio.h>
    int x= -1;
    int main(){
        int _2 = 2, extern, loop;
        scanf("%d %d" extern, loop);
    if(loop = _2){
        switch(extern)
          case 1;
            printf('One\n');
            break
          case 2;
            printf("%d\n", 2)
          default;
            printf("%dn", x);
        }else if{
        printf("Compiler says, \"Unreachable Code\", ");
        }
        return 1;
    }
```

b) Consider the following structures that can be used to hold co-ordinates of all points of a quadrilateral. Write a user defined function that takes such a quadrilateral as argument and identify type of the quadrilateral (square/rectangle/rhombus/ parallelogram/other).   7


```
struct Point{
    double x, y;
};

struct Quadrilateral{
    struct Point a, b, c, d;
};
```
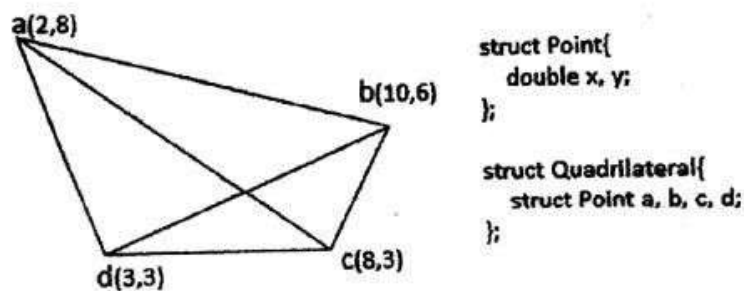
c) Re-write the following code segment using only if...else instead of ternary operator '?'.   4
$$int\ x = a > b\ ?\ a < c\ ?\ c : a : b > c\ ?\ b : c;$$

d) Find output of the following block of code.   7
```
#include <stdio.h>
int a = 50, gcount = 0, lcount = 0;
int printMeAgain(int b) {
        printf("%d: %d\n", ++gcount, ++b);
        return a++;
}

int printMe(int a) {
        printf("%d %d\n",++lcount, ++a);
        return printMeAgain(a);
}

int main() {
        int a = 100;
        printf("%d\n", a);
        if (printMe(printMeAgain(a++))) {
                int a = printMe(printMeAgain(printMe(30)));
                printf("%d\n", a);
        }
        printMe(a);
        return 0;
}
```
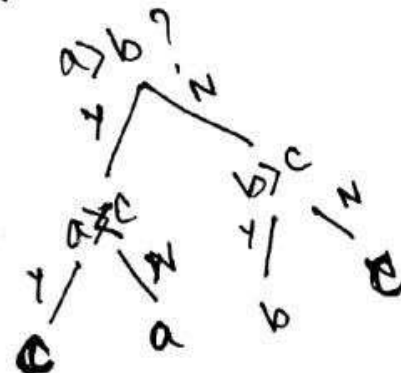
$2n - 3 = t$

$2 \, dn = dt$

$\frac{2}{3}(2x-3)^{2}$

University of Dhaka
Department of Computer Science and Engineering
1st Year 2nd Semester B.Sc. Final Examination, 2020
MATH-1204: Methods of Integration, Differential Equations and Series

Total Marks: 70   **Time: 2 Hours**

(Answer any 3 (Three) of the following Questions)

1. a) Evaluate the following indefinite integrals: 4x2=8

    (i) $\int \frac{t^3 - 2t^2 + 2t - 2}{t^2 + 1} \, dt$ by partial fraction. $\frac{t^2}{2} - 2t + \frac{1}{2}\ln(t^2+1)$

    (ii) $\int x^3 \sqrt{2x-3} \, dx$ by tabular method. $\frac{n^3}{3}\frac{n^{3/2}}{2}$ $3n^2$ $\frac{9}{2}$ $\frac{24n}{15}$ $\frac{9}{2}$ $\frac{24}{45} \times \frac{2}{3}$

    b) Evaluate the following definite integrals: 4x2=8

    (i) $\int_0^{\frac{\pi}{6}} \sec^3 2\theta \tan 2\theta \, d\theta$ (ii) $\int_{\sqrt{2}}^{2} \frac{\sqrt{2x^2 - 4}}{x}$ $2 - \frac{\pi}{2}$

    $\frac{\pi}{6}$ 7.33

    c) Using Simpson's $\frac{1}{3}$ rule, evaluate $\int_{0.2}^{1.4} (\sin x - \ln x + e^x) \, dx$.

                                                                                 7

2. a) Find the exact arc length of the curve $x = \frac{y^4}{8} + \frac{1}{4y^2}$ from $y=1$ to $y=4$.

                                                                                 7

    b) Calculate the area of the surface of revolution obtained by revolving the curve

    $y = \frac{1}{3}(x^2 - 2)^{3/2}$ from $x=1$ to $x=3$ about the y-axis.

    c) A football is thrown from a height of 6 feet with an initial speed 80 ft/s at an angle of   9.33
        $8°$. A person stands 40 yards downfield in the direction of the flow. Is it possible for
        the person to catch the ball?

3. a) Find the point on the cardioid $r = 1 - \cos\theta$ at which there is a horizontal line, a vertical   8
        line and a singular point.

    b) Given that $x = t^2$, $y = t^3$, $-\infty < t < \infty$. Calculate $\frac{dy}{dx}$ and $\frac{d^2 y}{dx^2}$ at $(1, 1)$ without   8

        eliminating the parameter.

    c) Find the area of the region that is inside of the cardioid $r = 4 + 4\cos\theta$ and outside of the   7.33
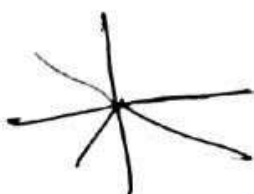   circle $r = 6$.

4. a) Sketch the graphs of the parabolas $y^2 - 8x - 6y - 23 = 0$ and show the focus and   8
        directrix.   hyperbola

    b) Find the constants a, b, and c for the ellipse $r = \frac{2}{1 + 2\sin\theta}$ and sketch the graph.   8

    c) State Taylor series with remainder. Expand $f(x) = \sin x$ in powers of $\left(x - \frac{\pi}{2}\right)$ with   7.33

        Taylor's remainder.

5. a) Solve the differential equation: $\frac{dy}{dx} = 3(x+1)^2 y$, $y(0) = 1$.   11

    b) If the population of a country doubles in 50 years, in how many years will it treble itself   12.33
        under the assumption that the rate of change of population at anytime is proportional to
        the population at that time?

$y - 3 = 1(n+6)$

$n^2 + y^2 = r^2 - x$ $\Rightarrow y - 3 = n + 6$

$\sqrt{x^2 + y^2} = \sqrt{n^2 + y^2}$ $\Rightarrow 1$