BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-I B.Sc. Engineering Examination 2019-20 (January 2020 Term)

Sub: **EEE 101** (Electrical Circuits I)

Full Marks: 180 Time 2 Hours

The Figures in the margin indicate full marks.
All the symbols have their usual meanings.
Assume reasonable values for missing data.
USE SEPARATE SCRIPTS FOR EACH SECTION

There are a total of 5 (Five) pages in this question paper.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE.**

1. (a) The voltage and current at the terminals of a circuit element are shown in the figures below. Sketch the power versus t plot for $0 \le t \le 10$ s. Also, calculate the energy delivered to the element in 10 s. (15)

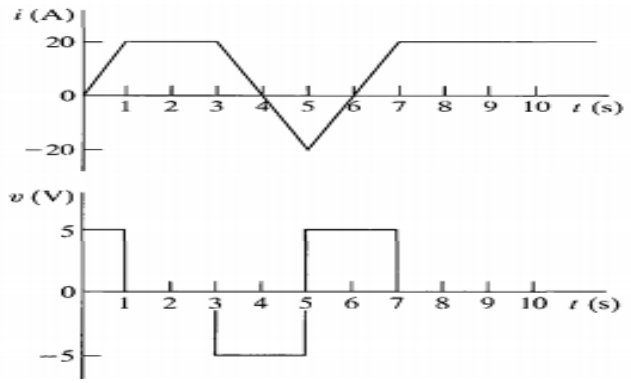

Fig. for Q. 1(a)

(b) A battery provides 12.5 V to a radio and 11.7 V to a light bulb. The radio and light bulb can be modeled as 6.25 Ω resistor and 0.65 Ω resistor, respectively. Find the Thevenin and Norton equivalents of the battery. (15)

2. (a) The variable DC source in the following circuit is adjusted so that i is zero. Find the value of V_{dc}. (15)

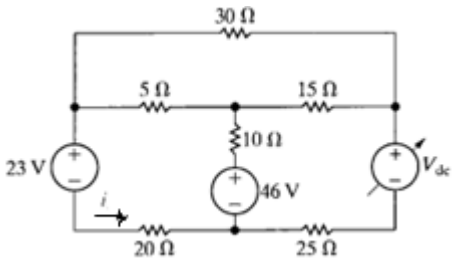

Fig. for Q. 2(a)

(b) Use mesh-current method to find the power dissipated in the 1 Ω resistor in the circuit shown. (15)

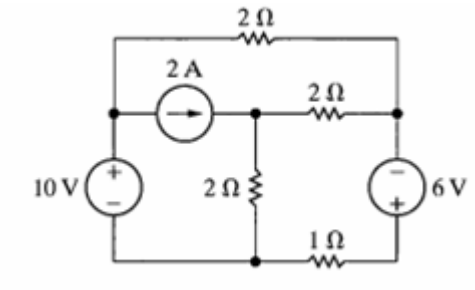

Fig. for Q. 2(b)

3. (a) Find the current delivered by the 48 V source. (15)

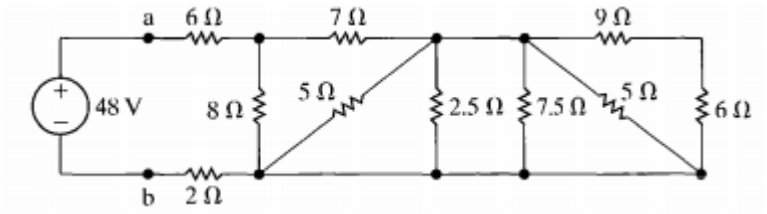

Fig. for Q. 3(a)

(b) Find the value of R_1 and R_2 in the following circuit. (15)

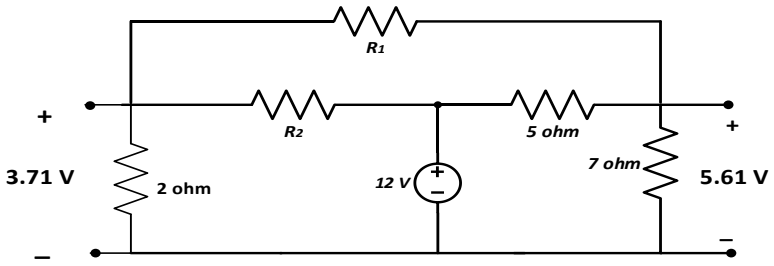

Fig. for Q. 3(b)

4. (a) For the circuit shown, determine the value of R such that the maximum power delivered to the load R_L is 3 mW. Write the laws, methods and/or theorems you used in solving it. (15)

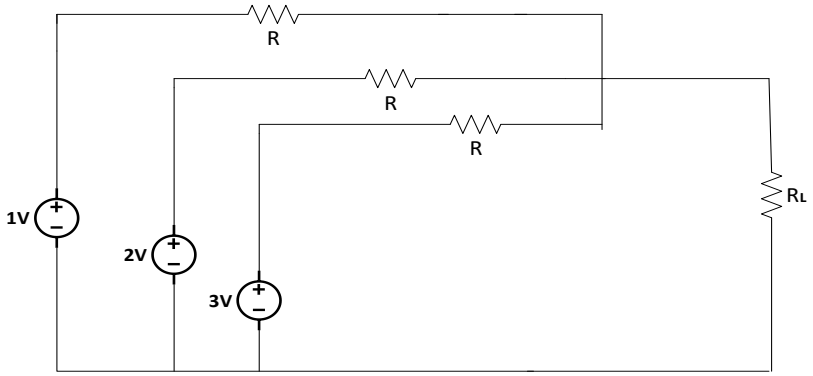

Fig. for Q. 4(a)

(b) Use superposition theorem to calculate V_0 for the circuit shown. Also, calculate the power absorbed by the 4Ω resistor. (15)

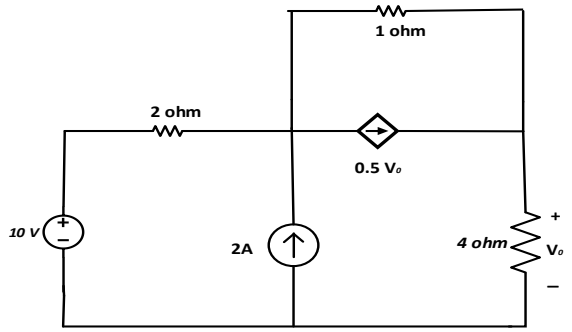

Fig. for Q. 4(b)

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**

5. (a) Find $i_2(0)$, $i_1(t)$ and $i_2(t)$ for the circuit shown in Fig. for Q. 5(a). Given that $v(t) = 12e^{-3t}$ mV for $t > 0$ and $i_1(0) = -10$ mA. (15)

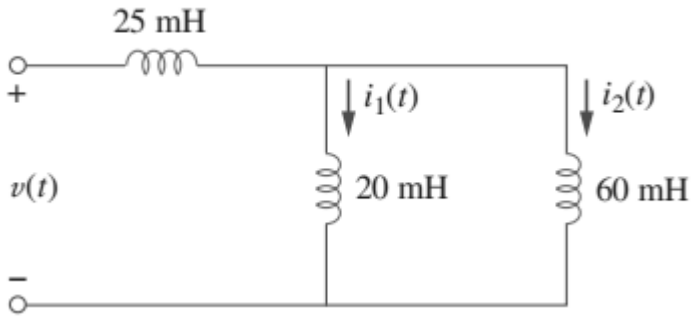

Fig. for Q. 5(a)

(b) The two switches in the circuit shown in Fig. for Q. 5(b) have been closed for a long time. At t= 0, switch 1 is opened. Then, 35 ms later, switch 2 is opened. Find (i) $i_L(t)$ for $0 \leq t \leq 35$ ms, (ii) $i_L(t)$ for $t \geq 35$ ms and (iii) What percentage of the initial energy stored in the 150 mH inductor is dissipated in the 18 Ω resistor? (15)

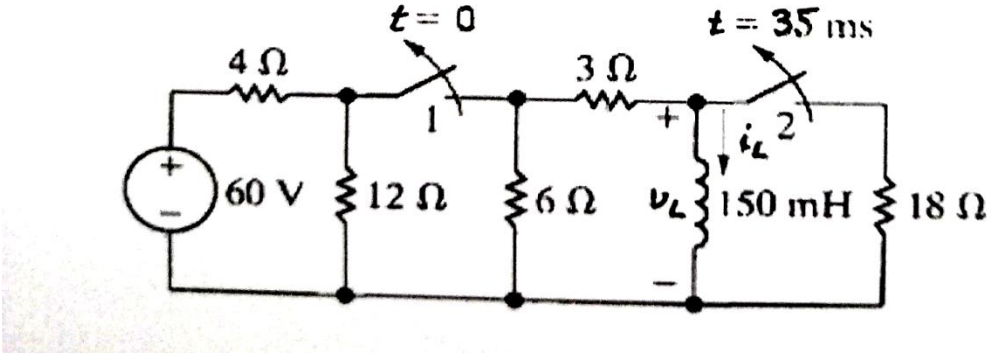

Fig. for Q. 5(b)

6. (a) (a) The switch in Fig. for Q. 6(a) has been closed for a long time before opening at $t = 0$. Find $i_L(t)$, $v_L(t)$ and $i_\Delta(t)$ for $t \geq 0$. (15)

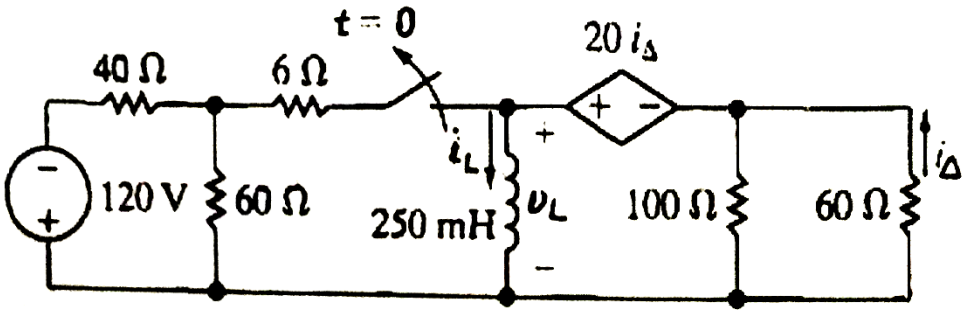

Fig. for Q. 6(a)

(b) The load impedance Z_L in the circuit shown in Fig. for Q. 6(b) is adjusted until maximum average power is delivered to Z_L. Find the value of Z_L and the maximum average power delivered to Z_L. (15)

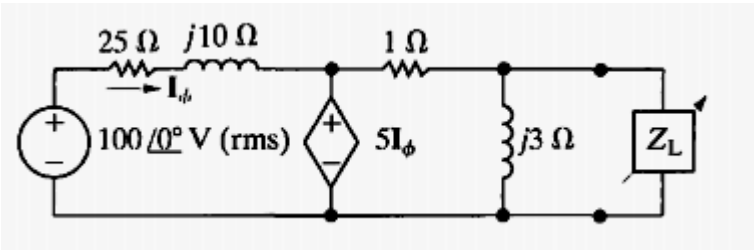

Fig. for Q. 6(b)

7. (a) Assume that the switch in the circuit shown in Fig. for Q. 7(a) has been in position a for a long time and that at $t = 0$ it is moved to position b. Find $i(0^+)$, $v_C(t)$ and $i(t)$ for $t \geq 0$. (18)

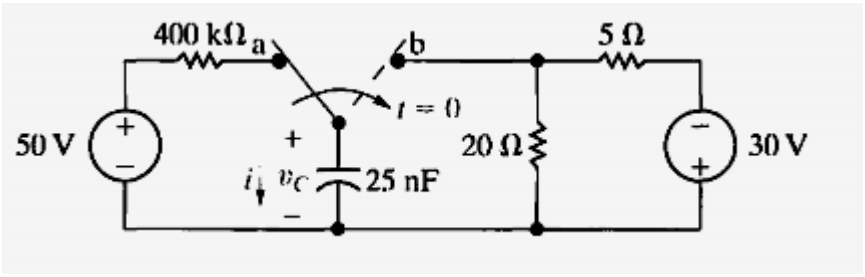

Fig. for Q. 7(a)

(b) If the current shown in Fig. for Q. 7(b) flows through a 9 Ω resistor, calculate the average power absorbed by the resistor. (12)

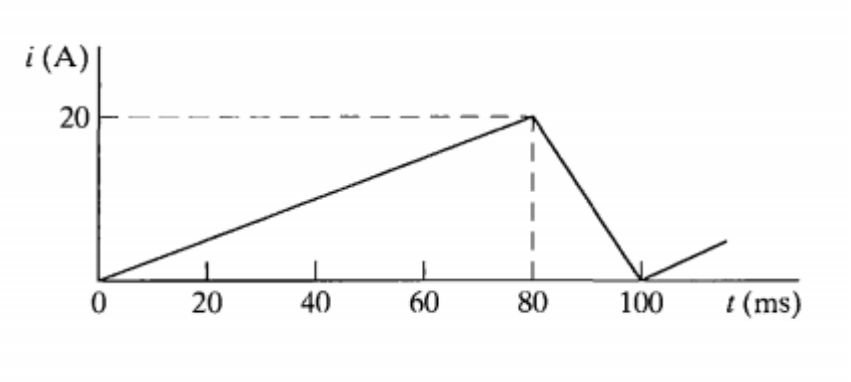

Fig. for Q. 7(b)

8. (a) Find I_0 and the overall complex power supplied for the circuit shown in Fig. for Q. 8(a). (15)

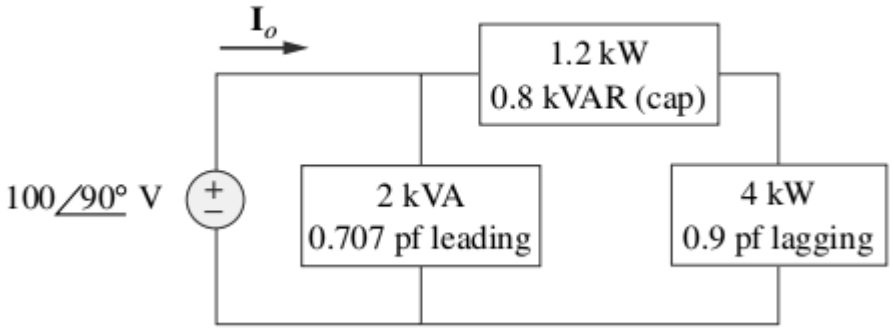

Fig. for Q. 8(a)

(b) Two loads connected in parallel draw a total of 2.4 kW at 0.8 pf lagging from a 220 V (rms), 50-Hz line. One load absorbs 1.5 kW at a 0.707 pf lagging. Determine: (i) the pf of the second load, (ii) the parallel element required to improve the pf to 0.9 lagging for the two loads. (15)

L-1/T-1/EEE **Date: 14/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

B. Sc. Engineering Examinations January 2020

Sub: **PHY 121** (Waves & Oscillation, Optics and Thermal Physics)

Full Marks: 180 Time: 2 Hours

The figures in the margin indicate full marks. Symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION-A

There are **FOUR** questions in this Section. Answer any **THREE**

1. (a) Draw the construction for the Lloyd's single mirror. Discuss the similarities and dissimilarities in principle of Lloyd's single mirror as compared with that of the Young's double slit experiment. Also explain why the extra path difference $\lambda/2$ occurs in reflection of light from the surface of the denser medium? [16]

   (b) The angle of minimum deviation for a thin prism is approximated as $\delta = (\mu - 1)\alpha$, where μ is refractive index of the prism material and α is the prism angle. The deviations produced by the blue, red and mean yellow rays of light are δ_b, δ_r and δ, respectively. Deduce and show that the dispersive power of the material of the prism is independent of the prism angle. [14]

2. (a) Mention some applications of interference and diffraction of light in daily life. Explain the phenomenon of Fraunhofer Diffraction due a circular aperture. [22]

   (b) Find the wavelength of light that has its third minimum at an angle of 48.6° when it falls on a single slit of width 3.00 μm. [8]

3. (a) Derive the equation for the resolving power of a grating and hence show that resolving power is directly proportional to (i) the order of the spectrum '*n*' and (ii) the total number of lines on the grating '*N*'. [22]

   (b) Calculate the minimum number of lines in a grating which will just resolve the sodium lines in the 2nd order spectrum. The wavelengths are 589 nm and 589.6 nm. [8]

4. (a) Explain how latent heat of vaporization helps in cooking the food faster in a pressure cooker. [8]

   (b) The vapor pressure of dichloromethane was measured as a function of temperature and the following results were obtained:

Temperature (K)	200	220	240	260	280	300
Pressure (Torr)	0.8	4.5	21	71	197	391

(i) Draw a Clausius-Clapeyron plot. Lebel the axes appropriately. Fit the data to a straight line.

(ii) Write down the equation for the Clausius-Clapeyron plot.

(iii) Determine the latent heat of vaporization of dichloromethane. [22]

SECTION-B

There are **FOUR** questions in this Section. Answer any **THREE**

5. (a) A graphical representation of the Maxwell distribution function is shown in figure 1 at 100 K, 200 K, and 300 K for H_2 gas molecules.

(i) What is meant by the peak and area of these curves?

(ii) Explain why the shape of the curve changes with temperature? [10]

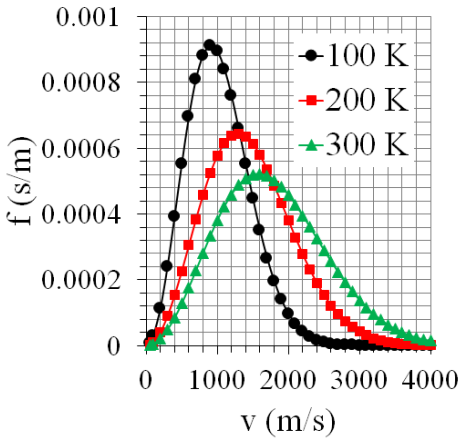

Figure 1

(b) The Maxwell-Boltzmann distribution function (f) calculated as a function of speed (v) for an oxygen gas molecule and the following results were obtained:

$v\ (m/s)$	50	200	300	400	500	650	100
$f\ \times 10^{-3}(s/m)$	0.122	1.54	2.51	2.85	2.51	1.40	0.082

(i) Plot a graph with f as ordinate v as abscissa.

(ii) From this graph, estimate the most probable speed of the oxygen gas molecule. [20]

6. (a) A heat engine consists of 1 mole gas is taken through the rectangular reversible cycle, as shown in the figure 2. Q_1 heat is absorbed in process bc at T_1 and Q_2 heat is rejected in process da at temperature T_2. Find the work done in each process of the cycle. [20]

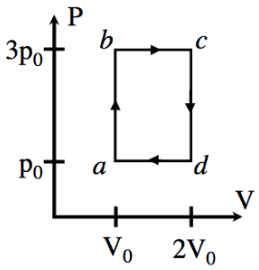

Figure 2

(b) An ideal gas in a sealed container is taken through the process shown in the PV diagram (figure 3). The initial volume (V_i) and pressure (P_i) of the gas are $0.125\ m^3$ and $35000\ Pa$, respectively. The final volume (V_f) and pressure (P_f) of the gas are $0.375\ m^3$ and $80000\ Pa$, respectively. What is the work done on the gas during the process shown in the figure 3? [10]

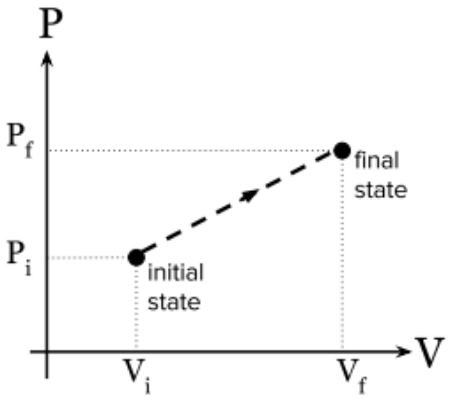

Figure 3

7. (a) In presence of dissipative forces how the equation of free-vibration is modified? Write down the solution of a damped harmonic motion and hence explain the under damped condition mathematically? [20]

   (b) A harmonic oscillator of quality factor 12 is subjected to a sinusoidal applied force of frequency one and half times the natural frequency of the oscillator. If the damping be small, obtain the amplitude of the forced oscillation in terms of its maximum amplitude. [10]

8. (a) Find out an expression for the growth of intensity of sound in a room in the case of reverberation. [20]

   (b) For clear audibility of speech or music in an auditorium, what types of measure should be taken? [10]

L-1/T-1/EEE Date: 11/01/2021

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2019-2020

Sub: **CSE 109** (Computer Programming)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Consider the following partial class definition *Student*. The class has two member variables: *stdid* and *stdname*. We want to store each student's id (e.g., 201906012) and full name (e.g., Fahim Hasan) in the *stdid* and *stdname* variables, respectively. The maximum length of a student's full name can be 50 characters.

```
class Student
{
        char stdid[10];
        char * stdname;
public:
        Student(char * id, char * name); //constructor function
        //Implement destructor and copy constructor functions
};
```

Implement the following member functions for the above class *Student*:

i. Implement the constructor given in the class. The constructor uses the *id* and *name* parameters to initialize the *stdid* and *stdname* member variables. You should allocate appropriate amount of dynamic memory for the *stdname* variable using the C++ new operator. 8

ii. Implement a destructor function for the class *Student*. 6

iii. Implement a copy constructor for the class *Student*. 10

(b) What is the main benefit of using inline functions in C++? Why should you not make every function inline in a C++ program? 6

2. (a) What is wrong with the following program? Add only appropriate codes to the *Demo* class to correct the program. Do not change the *main* function. 8

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

class Demo
{
        int a;
public:
        Demo(int arg){ a = arg; }
};
int main()
{
        Demo * d = new Demo[5];
        return 0;
}
```

(b) Define a macro *AREA(x)* that computes the area of a circle whose radius is specified by the macro parameter x. Your macro should correctly compute the area when arithmetic expressions are used as arguments to call the macro. 6

(c) What is the difference between text files and binary files? Implement the following C function to concatenate two files: 4+12 =16

```
void concat_files(char * in1, char * in2, char * out);
```

The function has three parameters that denote three distinct filename strings. The first two strings *in1* and *in2* denote the two input filenames, and the third parameter out denotes the output filename. Your job is to read the contents of two input files and produce their concatenated output (contents of *in1* followed by the contents of *in2*) in the output file. Note that you should not use any temporary array as a buffer to store file contents. Assume that input files will always be available and output file should be created as a new file.

3. (a) Briefly explain the three most important features of an object oriented programming language using relevant example codes in C++. 12

(b) Write two important differences between a pointer and a reference variable in C++. What are the implications of the following two expressions in C++ considering that *p1* and *p2* are object pointers and *r1* and *r2* are object references? 4+5 = 9

```
p2 = p1;
r2 = r1;
```

(c) For each of the three cases mentioned below, give example programs of function overloading that will create ambiguity. 9

i) Ambiguity due to type conversion.
ii) Ambiguity due to default arguments.
iii) Ambiguity due to reference parameters.

4. (a) Consider the following two *struct* definitions in a C program. 12

```
struct Point
{
        double * x; //points to the memory where x coordinate is stored
        double * y; //points to the memory where y coordinate is stored
};
struct Line
{
        struct Point p1;  //first point on a line
        struct Point p2;  //second point on a line
};
```

The first *struct Point* will be used to store a point's *x* and *y* coordinates using dynamic memory allocation to the given member variables which are pointers. The second *struct Line* defines a straight line using two points anywhere on the line. Note that *Line* defines a straight line of infinite length and not a line segment which has endpoints.

You task is to implement the following C function named *intersect*.

```
int intersect(struct Line * l1, struct Line * l2);
```

The function receives two lines as input where appropriate memory addresses of two *Line* variables will be passed as arguments to call the function. The function will return 1 if the two straight lines given as parameters intersect; otherwise return 0.

(b) Consider the following partial implementation of a C++ program. The program uses inheritance to create a class *Point3D* that is used to store and manipulate 3-dimensional points.

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

class Point2D
{
        double x, y;
public:
        Point2D(){ cout << "Base" << endl; }
        void set_x(double arg){ x = arg; }
        void set_y(double arg){ y = arg; }
        double get_x(){ return x; }
        double get_y(){ return y; }
};

class Point3D : public Point2D
{
        double z;
public:
        Point3D(double x, double y, double z)
        {
                //write codes to initialize a Point3D object with parameters x, y, and z.
        }
        double dist(Point3D &rhs)
        {
                //write codes to calculate the distance between this point and rhs
        }
};

int main(void)
{
        Point3D p1(1.0,2.0,3.0);
        Point3D p2(3.0,4.0,5.0);
        double d = p1.dist(p2);
        cout << d << endl;
        return 0;
}
```

Now, answer the following questions: 5+8+5 = 18

(i) Implement the given constructor of the *Point3D* class.

(ii) Implement the *dist* function so that the third line in the main function correctly computes the Euclidean distance between the points *p1* and *p2*. Do not add anything to the *Point2D* class and main function.

(iii) Suppose we change the keyword "public" in the line "class Point3D : public Point2D" to "private". Do you need to make any changes to your implementation of the *dist* function? If yes, mention the changes briefly.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2019-2020

Sub: **CSE 109** (Computer Programming)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. a) What is the difference between variable declaration and variable definition in C? Differentiate between local and global variables with appropriate examples. (6+6)

b) What is the output of the following C code? Explain how? (6)

```
#include<stdio.h>
int main(){
    int i=2,j=2;
    while(i+1?--i:j++)
        printf("%d",i);
    return 0;
}
```

c) What is the difference between `'a'` and `"a"`? (6)

d) What value will be assigned to the variable X for the expression X = a/b+c*d-c ; if a = 10, b = 20, c = 30, d = 40? Explain how? (6)

6. a) Write a program in C to find and display all the factors of an integer entered by a user. (10)

b) Write a code segment that will calculate the sum of n terms of the following series: (10)

$1 - 1/2^2 + 1/3^2 - 1/4^2 + 1/5^2 + \ldots \; 1/n^2$

c) Write a C program to find the maximum and the minimum element in an array using recursion. (10)

7. a) Write a C program to interchange diagonals of a square matrix. (12)

b) Write short notes on: call by value and call by reference. (8)

c) What will be the output of the following program? Explain how? (10)

```
#include<stdio.h>
void fun(int*, int*);
int main()
{
    int i=5, j=2;
    fun(&i, &j);
    printf("%d, %d", i, j);
    return 0;
}
void fun(int *i, int *j)
{
    *i = *i**i;
    *j = *j**j;
}
```

8. a) Write a C program to read any string from user and remove last occurrence of a given character from the string. (12)

b) What is Dynamic Memory Allocation (DMA)? Mention the advantages of it over static memory allocation. (10)

c) If p is a pointer, what does p[-2] mean? When is this legal? (4+4)

L-1/T-1/EEE Date: 21/01/2021

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2019-2020

Sub: **MATH 157** (Calculus I)

Full Marks: 180 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION -A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) A function is defined as follows: (15)

$$f(x)=\begin{cases} x\sin(1/x), & \text{if } x\neq 0 \\ 0, & \text{if } x=0. \end{cases}$$

Discuss the differentiability of $f(x)$ at $x = 0$.

(b) On a sunny day, a 50 ft flagpole casts a shadow that changes with the angle of elevation of the Sun. Let s be the length of the shadow and θ the angle of elevation of the Sun. Find the rate at which the length of the shadow is changing with respect to θ when $\theta = 45^{\circ}$. Express your answer in units of feet/degree. (15)

2. (a) State Leibnitz's theorem. If $y^{\frac{1}{m}}+y^{-\frac{1}{m}}=2x$, , then compute y_{n+2}. (15)

(b) Find the value of θ in the Lagrange's form of remainder for the expansion of $\frac{1}{1-x}$ in powers of x. (15)

3. (a) If $u=\tan^{-1}\frac{x^2+y^2}{x-y}$, show that $x\frac{\partial u}{\partial x}+y\frac{\partial u}{\partial y}=\sin 2u$. (15)

(b) Find the altitude of the right cone of maximum volume that can be inscribed in a sphere of radius a. (15)

4. (a) If the tangent at (x_1, y_1) to the curve $x^8+y^8=a^8$ meets the curve again at (x_2, y_2), then prove that $\left(\frac{x_2}{x_1}+\frac{y_2}{y_1}\right)=1$. (15)

(a) Find the radius of curvature at the point (x, y) on the curve $y=a\ln\sec(x/a)$ (15)

SECTION-B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Compute $\int \frac{coshx+2sinhx+3}{4coshx+5sinhx+6}dx$ and hence comment on your result. **(15)**

   (b) If $I_n = \int x^n e^x\, dx$, then show that $I_n = x^n e^x - nI_{n-1}$. Hence evaluate I_3. **(15)**

6. (a) Verify that $\left|\int_a^b f(x)dx\right| \leq \int_a^b |f(x)|dx$ for the following problems: **(20)**

   (i) $\int_{-1}^{4}(3x - x^2)dx$, and (ii) $\int_{-2}^{3} 6(x + 2 - x^2)dx$

   (b) Determine the average length of all vertical chords of the hyperbola **(10)**

   $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ over the interval $a \leq x \leq 2a$.

7. (a) Prove that $\int_0^1 \frac{dx}{\sqrt{1-x^4}} = \frac{\Gamma(1/4)\,\Gamma(1/2)}{4\Gamma(3/4)}$. **(10)**

   (b) Show that $\Gamma(5/3) \times \Gamma(-5/3) = \frac{2\pi\sqrt{3}}{5}$. **(10)**

   (c) Test the integral $\int_0^4 \frac{1}{(x-1)^2}dx$ for convergence and hence comment. **(10)**

8. (a) Determine the area bounded by $y(e^x - 1) = e^x + 1$ and $y(e^x - 1) = 1$ in the first quadrant from x = 1 to x = 2. **(15)**

   (b) Find the volume of the solids generated by revolving an arch of the cycloid $x = 2(\theta - sin\theta), y = 2(1 - cos\theta)$ about OX and OY respectively. **(15)**

L-1/T-1/EEE **Date: 25/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2019-2020

Sub: **MATH 159** (Calculus-II)

Full Marks: 180 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

SECTION-A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Find all the fifth roots of $-16 + 16\sqrt{3}i$ and locate them in the complex plane. **(15)**

   (b) Suppose $f(z) = {}^{1}/_{z} = u + iv$. Construct several members of the families $u(x, y) = \alpha, v(x, y) = \beta$ where α and β are constants. Show them in a graph. **(15)**

2. (a) Guess a possible value for $\lim_{z\to 2+i} \frac{z^2-2iz}{z^2+4}$ and investigate the correctness of your guess. **(15)**

   (b) Find the orthogonal trajectories of the following family of curves **(15)**

   $$e^{-x}\cos y + xy = \alpha.$$

3. (a) Evaluate $\oint_C \bar{z}^2 dz$ around the circle $C: |z - 1| = 1$. **(15)**

   (b) Let C be the circle $|z - 2| = 5$. **(15)**

   (i) Examine whether $\oint_C \frac{dz}{z-3} = 0$,

   (ii) Does your answer to (i) contradict Cauchy's theorem?

4. (a) Expand $f(z) = \frac{z^2}{(z-1)(2-z)}$ in a Laurent series valid for $0 < |z - 2| < 1$. **(15)**

   (b) Evaluate $\int_0^{2\pi} \frac{\cos 3\theta}{5+4\cos\theta} d\theta$. **(15)**

SECTION-B

There are **FOUR** questions in this section. Answer any **THREE**.

5. **(a)** If $\mathbf{a}, \mathbf{b}, \mathbf{c}$ are non-coplanar vectors then are the following four points coplanar? **(12)**
$-\mathbf{a}+4\mathbf{b}-3\mathbf{c}$, $3\mathbf{a}+2\mathbf{b}-5\mathbf{c}$, $-3\mathbf{a}+8\mathbf{b}-5\mathbf{c}$, $-3\mathbf{a}+2\mathbf{b}+\mathbf{c}$.

(b) Find the curvature, principal normal and binormal vectors of the space curve **(18)**
$\mathbf{r}(t) = e^t \sin(t)\mathbf{i} - \mathbf{j} + e^t \cos(t)\mathbf{k}$.

6. **(a)** Is the vector field $\mathbf{F} = yz\mathbf{i} + xz\mathbf{j} + xy\mathbf{k}$ irrotational? If so, find a scalar function u such that $\mathbf{F} = \nabla u$. **(17)**

(b) The temperature at a point on a metal plate in the xy-plane is given by $T(x, y) = 20 - 2x^2 - 3y^2$. Find a unit vector at $(-2, -6)$ in the direction in which the temperature drops most rapidly and find the rate of change of temperature in that direction. **(13)**

7. **(a)** Prove vectorially that $\mathbf{F} \times (\mathbf{G} + \mathbf{H}) = \mathbf{F} \times \mathbf{G} + \mathbf{F} \times \mathbf{H}$. **(14)**

(b) Determine the flux of the vector field $\mathbf{F}(x, y, z) = x^3\mathbf{i} + y^3\mathbf{j} + z^3\mathbf{k}$ over the surface ∂Q, where Q is the solid bounded by the hemisphere $z = 9 - x^2 - y^2$ and the xy-plane. **(16)**

8. **(a)** Verify Green's theorem in the plane for $\int_C (2x - y^2)dx + x^2 y dy$ where C is the boundary of the region enclosed by $x^2 + y^2 = 1$ and $x^2 + y^2 = 4$. **(17)**

(b) Evaluate $\oint_C \mathbf{F} \cdot d\mathbf{r}$ using Stokes' theorem, where $\mathbf{F}(x, y, z) = -3y\mathbf{i} - 2z\mathbf{j} + 3x\mathbf{k}$ and C is the triangle in the plane $y = \frac{z}{2}$ with vertices (2, 0, 0), (0, 2, 1) and (0, 0, 0) with counterclockwise orientation. **(13)**