BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2021-2022

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

Full Marks : 210 Time : 3 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) The switch in the circuit in the Figure for Q. 1(a) has been in position x for a long time. The initial charge on the 60 nF capacitor is zero. At t = 0, the switch moves instantaneously to position y. Find $v_0(t)$ and $v_1(t)$ for $t \geq 0$. **(18)**

   (b) Find $i_0(t)$ for the circuit of Figure for Q. 1(b) for $t > 0$. **(17)**

2. (a) Design the circuit in Figure for Q. 2(a)(i) to have the response in Figure for Q. 2(a) (ii). **(16)**

   (b) Find $v(t)$ for the circuit of Figure for Q. 2(b) for $t > 0$. **(19)**

3. (a) The gap in the circuit seen in Figure for Q. 3(a) will arc over whenever the voltage across the gap reaches 30 kV. The initial current in the inductor is zero. The value of β is adjusted so the Thévenin resistance with respect to the terminals of the inductor is – 4 kΩ. **(18)**

   (i) What is the value of β?

   (ii) How many microseconds after the switch has been closed will the gap arc over?

   (b) The circuit shown in Figure for Q. 3(b) is at steady state before the switch closes at time t = 0. The switch remains closed for 1.5 s and then opens. Determine the inductor current $i(t)$ for $t > 0$. **(17)**

4. (a) A cast steel magnetic circuit shown in Figure for Q. 4(a), has N = 2500 turns, I = 200 mA, and a cross-sectional area of 0.02 m^2. Assuming 90% of the mmf appears across the gap, estimate the flux in the core (ϕ_1, ϕ_2 and ϕ_3). Use the BH curves attached with the question. **(20)**

   (b) The flux in the air gap in the circuit of Figure for Q. 4(b) is 30 μWb and N = 2000 turns. Neglecting fringing, find current I. Use the BH curves attached with the question. **(15)**

Contd P/2

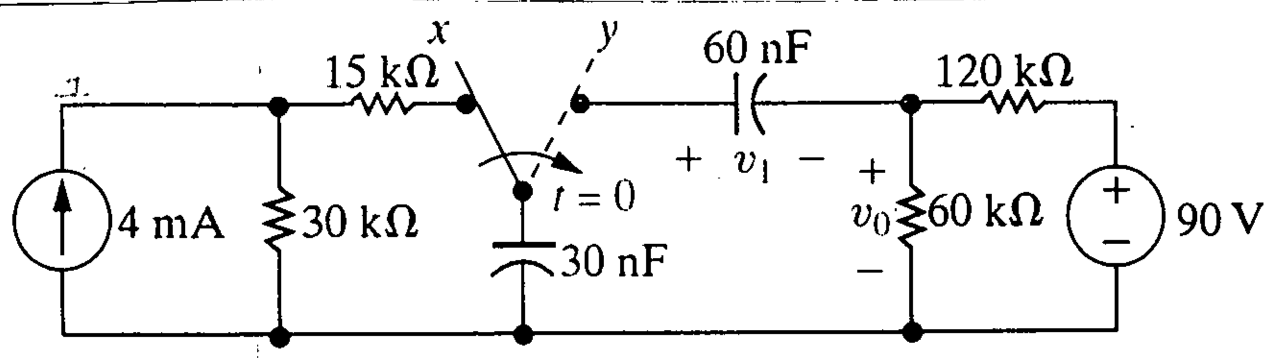


Figure for Q.1a

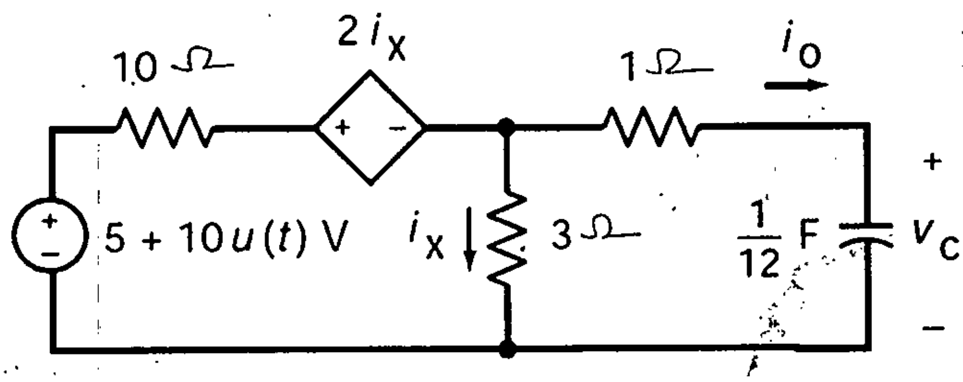


Figure for Q. 1b

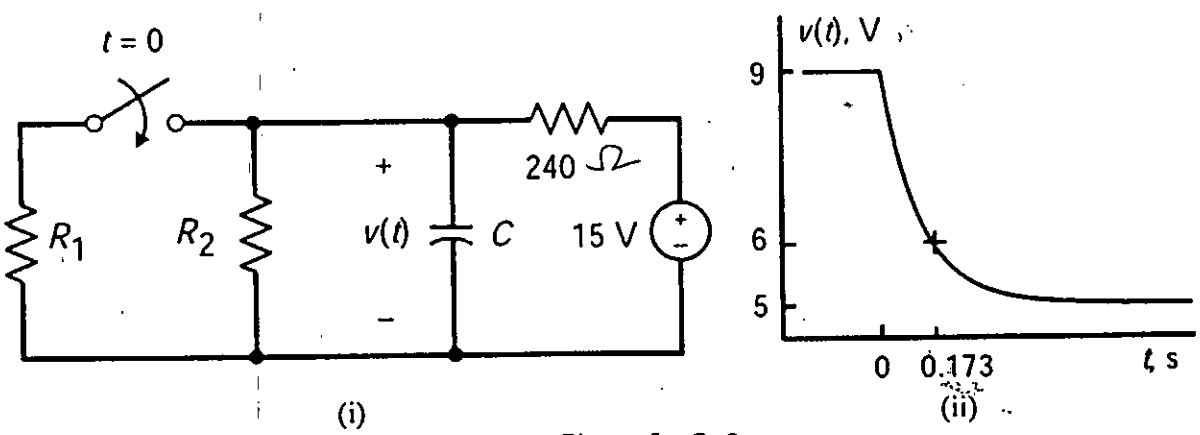


Figure for Q. 2a

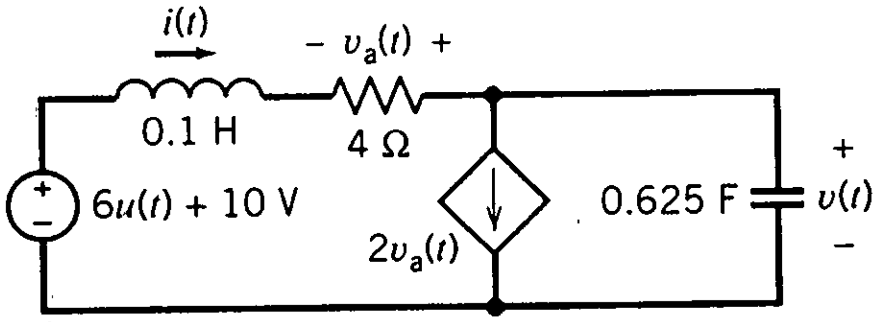


Figure for Q. 2b

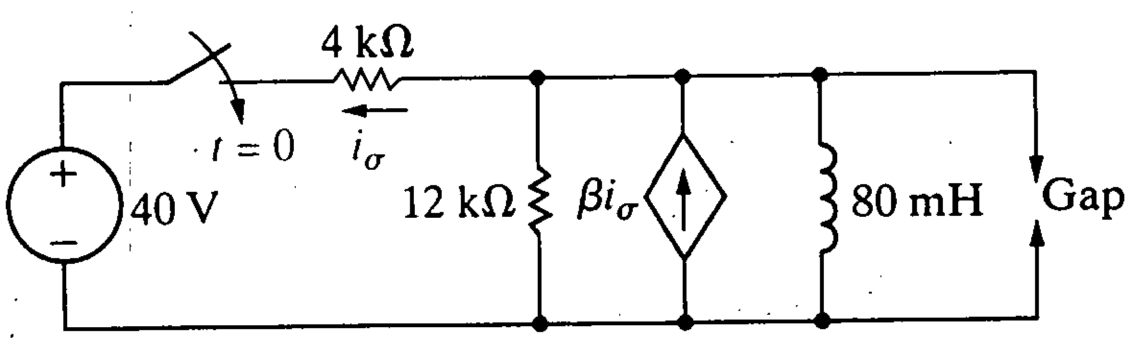


Figure for Q. 3a

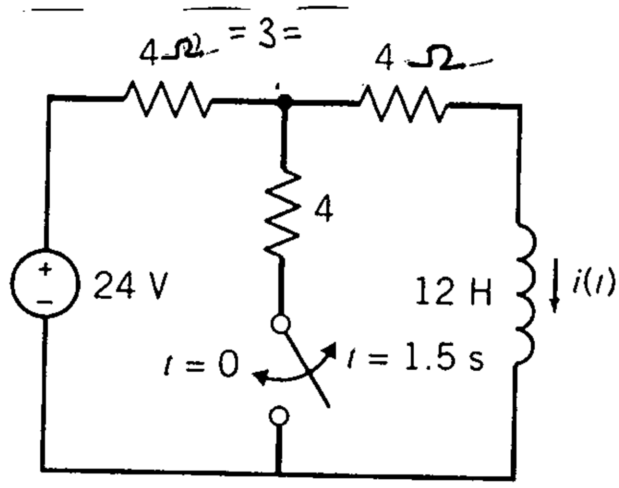


Figure for Q. 3b

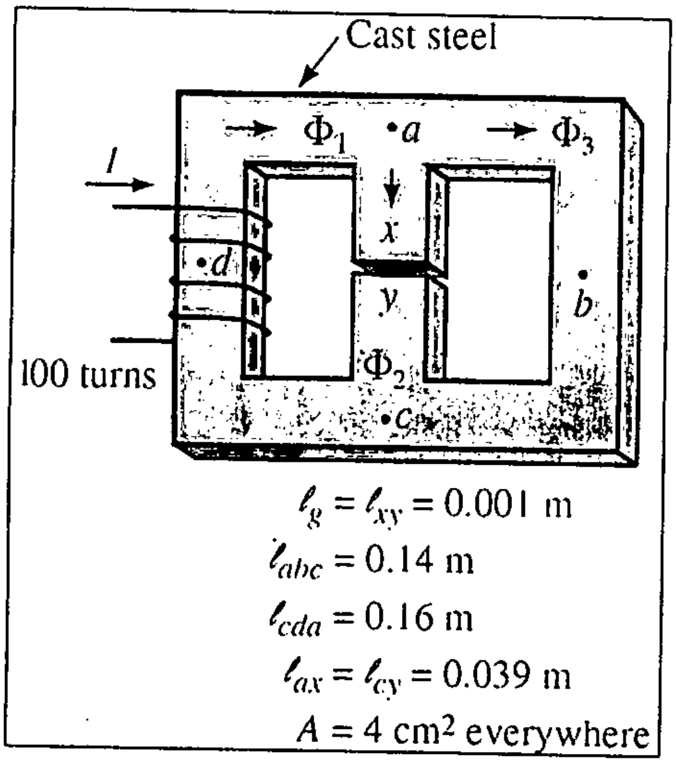


Figure for Q. 4a

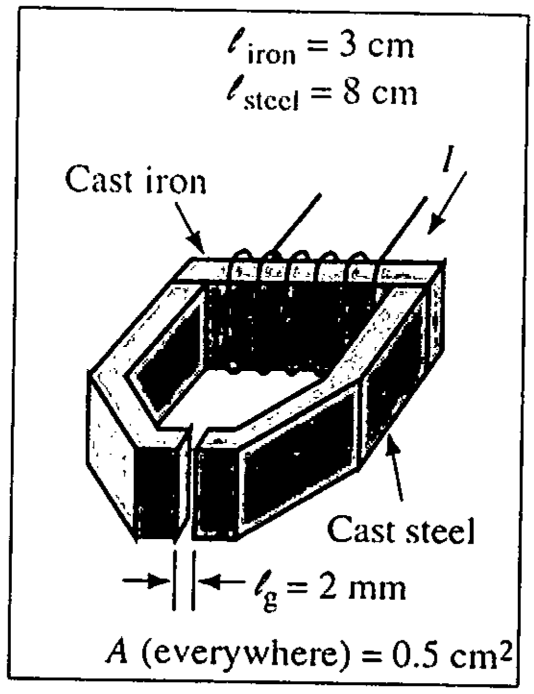
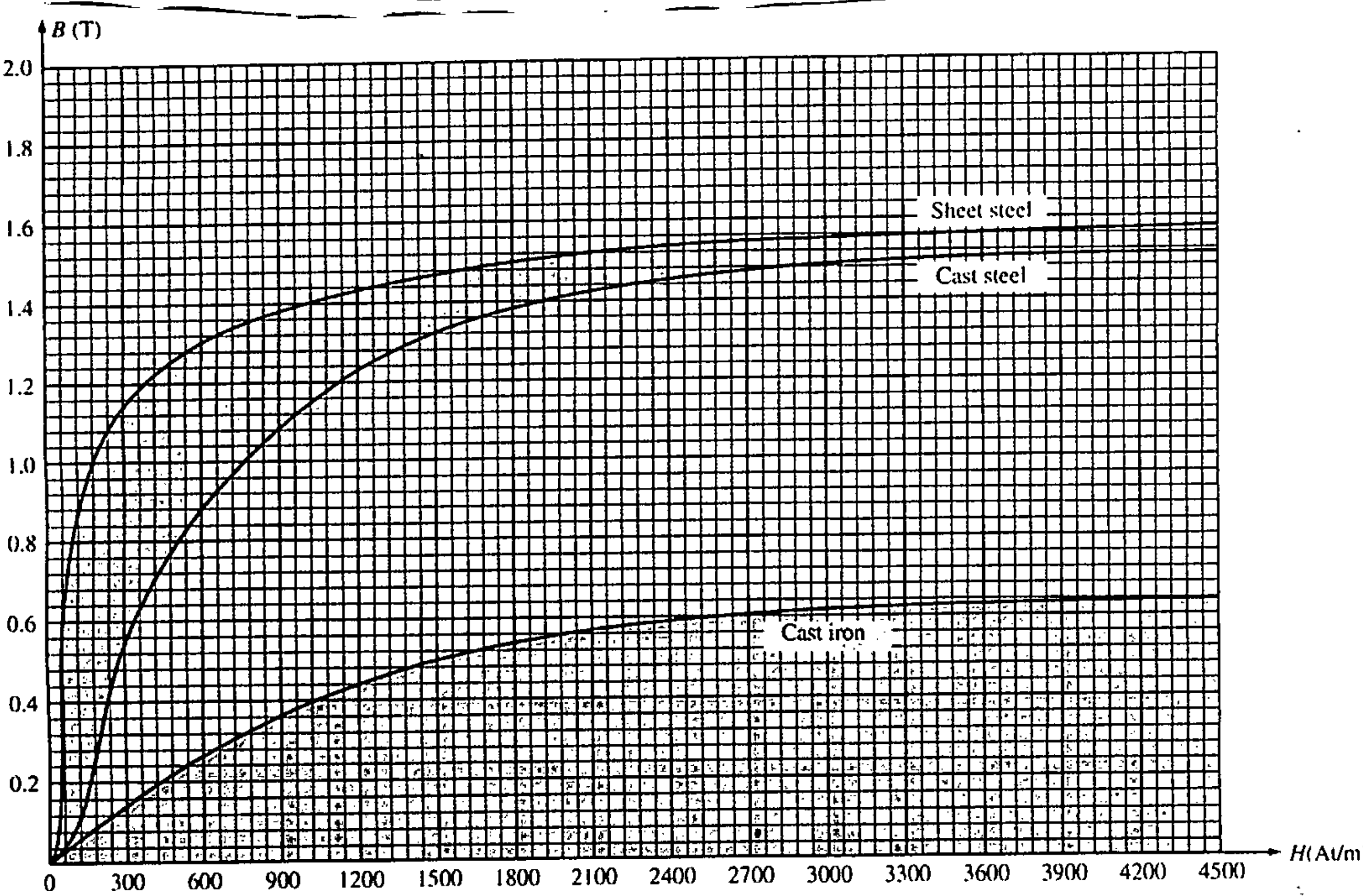


Figure for Q. 4b



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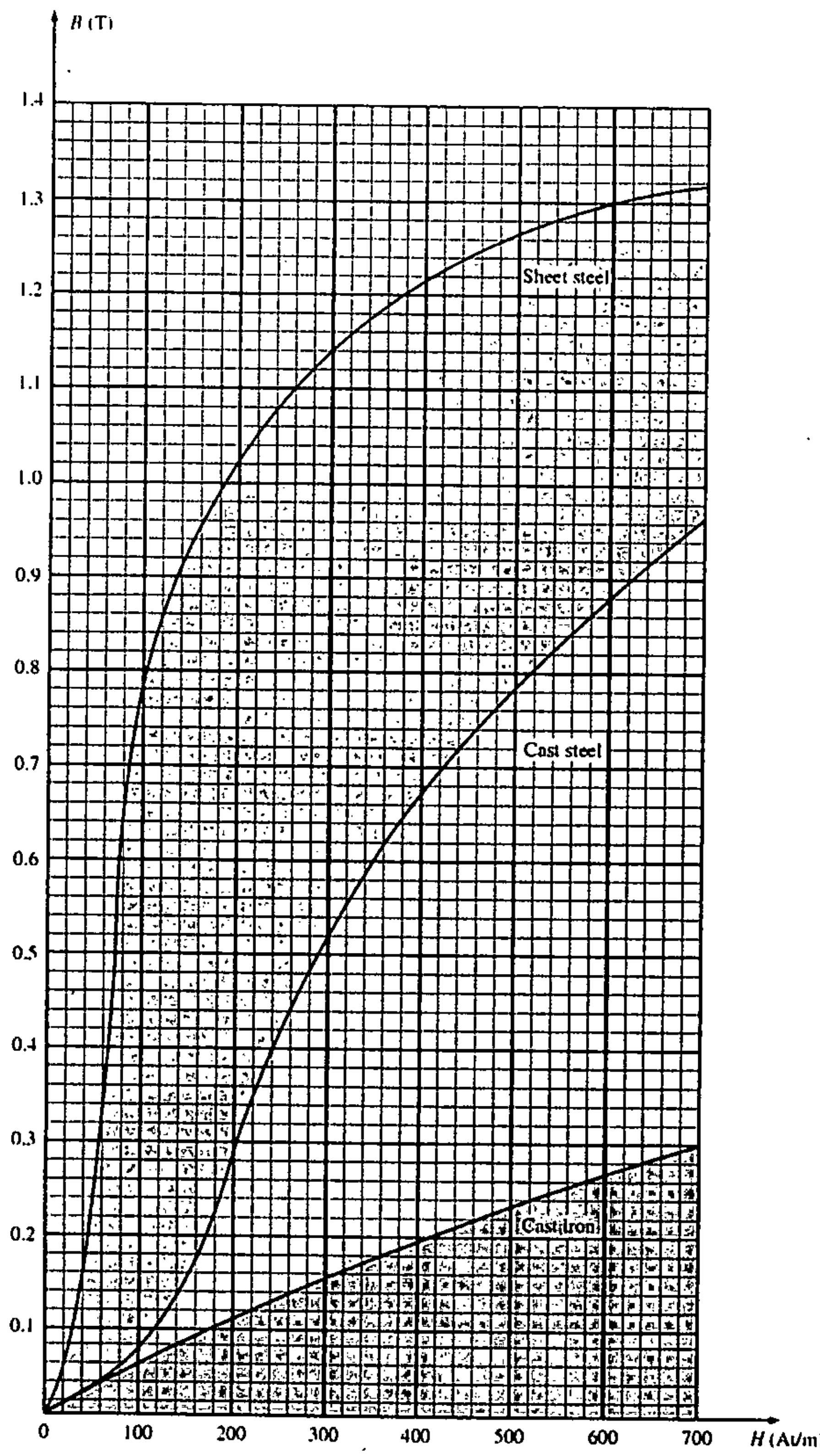
B (T)
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
100
200
300
400
500
600
700
H (At/m)
Sheet steel
Cast steel
Cast iron

Contd. P/5

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SECTION – B

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

5. (a) Find the equivalent resistances, R_{xy} and R_{yz} in the circuit shown in Fig. for Q. 5(a). **(16)**

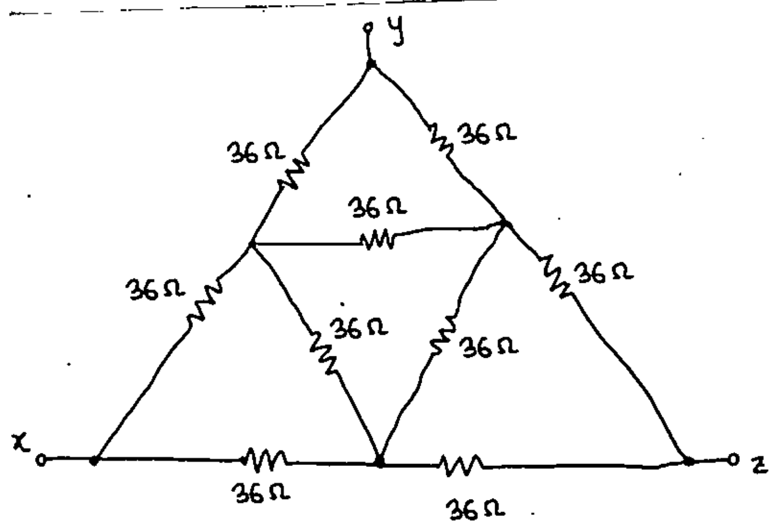

Fig. for Q. 5(a)

(b) State Kirchhoff's voltage law. Using mesh analysis, find all the mesh currents for the circuit shown in Fig. for Q. 5(b). Also, find power delivered by the 200 V voltage source. **(19)**

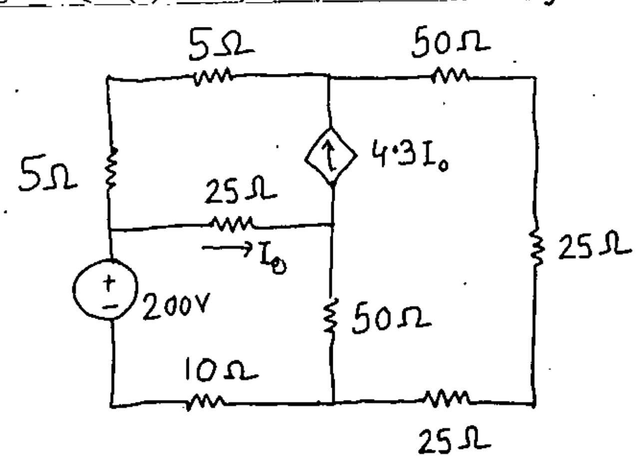

Fig. for Q. 5(b)

6. (a) Find V_0 and I_0 in the circuit shown in Fig. for Q. 6(a) using source transformation. **(17)**

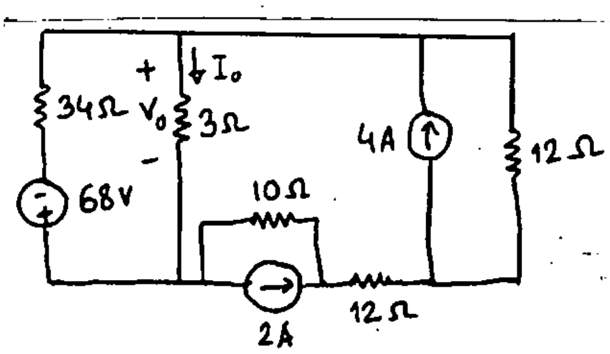

Fig. for Q. 6(a)

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Contd ... Q. No. 6

(b) Find I_0 using nodal analysis for the circuit shown in Fig. for Q. 6(b). Also, find all the node voltages of the circuit. **(18)**

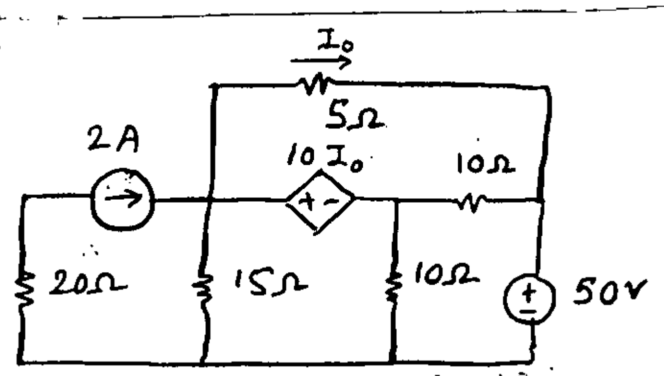

Fig. for Q. 6 (b)

7. (a) What is a linear circuit? State the superposition principle. Use superposition principle to find V_1 and I_1 in the circuit of Fig. for Q. 7(a). **(22)**

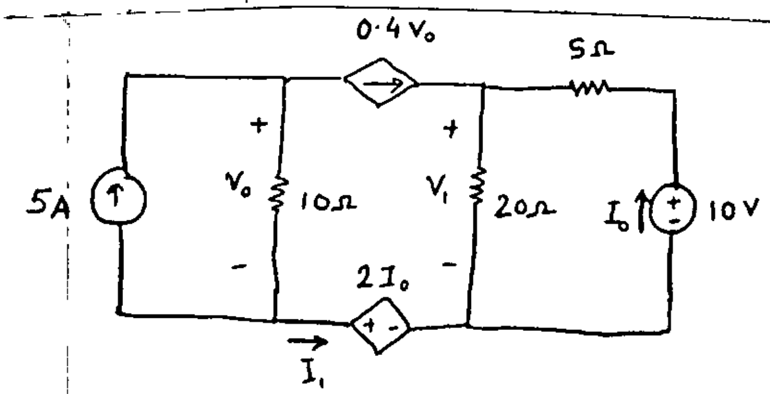

Fig. for Q. 7 (a)

(b) The current, I_0 in the circuit shown in Fig. for Q. 7(b) is 2 A. Calculate (i) V_S, (ii) the power adsorbed by the independent voltage source, (iii) the power delivered by the independent current source, (iv) the power delivered by the controlled current source, and (v) the power dissipated in 30 Ω and 10 Ω resistances. **(13)**

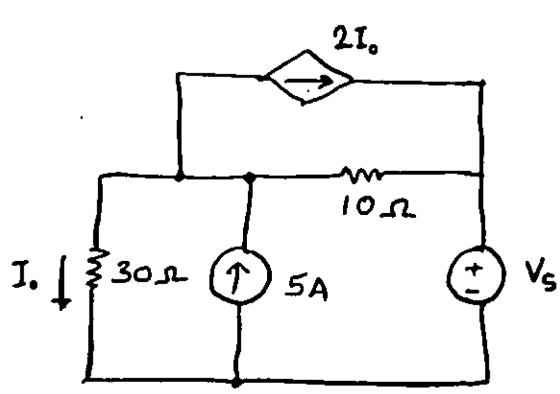

Fig. for Q. 7 (b)

Contd P/7

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8. (a) State Thevenin's theorem. Show that maximum power is transferred to the load when the load resistance equals the Thevenin resistance. **(8)**

(b) A variable load resistor, R_L is connected between terminals A-B in the circuit shown in Fig. for Q. 8(b). **(27)**

(i) Find the Thevenin and Norton equivalent circuits at terminals A-B.

(ii) R_L is adjusted for maximum power transfer to R_L. Find the value of R_L. Also, find the maximum power transferred to R_L.

(iii) How much power does the 560 V source deliver to the circuit when R_L is adjusted for maximum power transfer?

(iv) R_L is adjusted so that 40% of total power delivered in the circuit is in R_L. Find the value of R_L for this case.

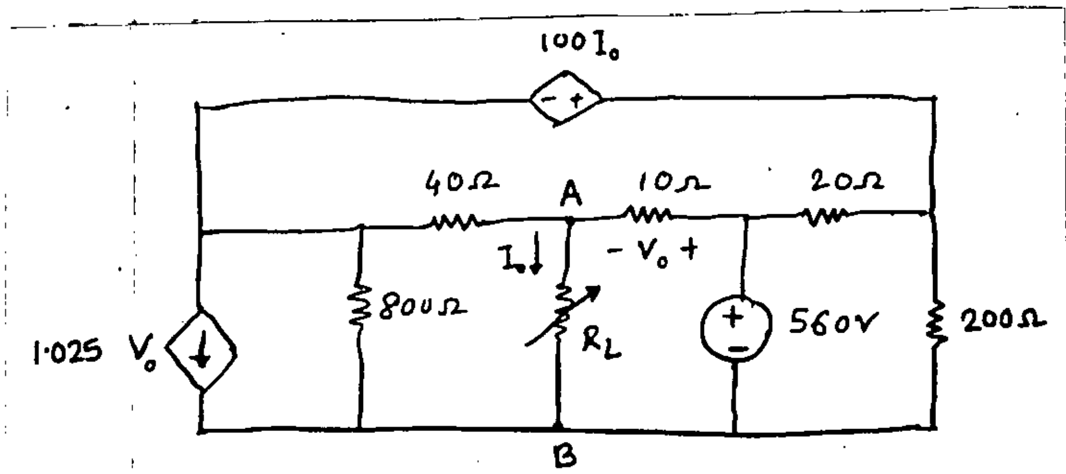

Fig. for Q. 8 (b)

L-1/T-1/EEE Date : 29/04/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2021-2022

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **NINE** questions in this section. Answer any **SEVEN** questions.

1. Write a C program that has the following features– **(15)**

   (a) Take two numbers m, n as input from user.

   (b) Dynamically allocate a 2D array of size m × n using pointer.

   (c) Release the memory of that array.

2. Write down the output of the following two programs. And explain why these output comes from these programs. **(10+5=15)**

   [Without proper explanation you will get no mark.]

   i.

```
#include <stdio.h>
int main()
{
    int a = 10,b = 12, c, d;

    c = a--;
    d = --b;

    printf("A: %d\n", a);
    printf("B: %d\n", b);
    printf("C: %d\n", c);
    printf("D: %d\n", d);

    return 0;
}
```

   ii.

```
#include <stdio.h>

int main()
{
    int x;
    x = 21 / 6 * 10 + 5 / 10 + 3;
    printf("X: %d", x);
    return 0;
}
```

Contd P/2

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3. Identify the problem of the following code, give proper explanation and rewrite the corrected version of the following code– **(15)**

```
#include <stdio.h>

int* takeArrayInput(int n)
{
    int a[n];
    for (int i = 0; i < n; i++) {
        scanf("%d", &a[i]);
    }
    return a;
}

int main()
{
    int n;
    printf("Enter the number: ");
    scanf("%d", &n);

    int *a = takeArrayInput(n);

    for (int i = 0; i < n; i++) {
        printf("%d ", a[i]);
    }

    return 0;
}
```

4. Briefly explain the following terms. **(5×3=15)**
   (a) Short Circuit Evaluation,
   (b) Symbolic Constant
   (c) Call by Reference

5. The **Tower of Hanoi** problem is a classic problem that consists of three pegs and a set of disks of different sizes. At first all the disks are placed in first peg. You need to move all of the disks from first peg to third peg using the help of second peg, while following certain rules: **(15)**
   (a) Only one disk can be moved at a time.
   (b) A larger disk cannot be placed on top of a smaller disk.
   (c) The disks can only be moved from the top of one peg to the top of another peg.
   Write a C program that takes number of disks as input and print the moves such that after performing these moves all the disks should moved from first peg to third peg.

Contd P/3

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6. Write down the output of the following program with proper explanation. Assume that the value of **p = 100**. **(3×5=15)**

   [Without proper explanation, you will get no mark.]

```c
#include <stdio.h>

int main()
{
    int i, s = 5;
    int *p = (int *) malloc(s * sizeof(int));

    for (i = 0; i < s; i++) {
        p[i] = (i+1) * 10;
    }

    printf("p        = %d\n", p); // value of p=100
    printf("p[1]     = %d\n", p[1]);
    printf("*p + 3   = %d\n", *p + 3);
    printf("p[3]     = %d\n", p[3]);
    printf("*(p + 2) = %d\n", *(p + 2));
    printf("p + 5    = %d\n", p + 2);

    free(p);

    return 0;
}
```

7. Write a C program that will cut a substring from a string. The program will take one string (`max_size = 100`) as input, one index from which we need to start cutting and length of the cut. Explain– for input "abcdefg", 2, 3 the resultant substring will be "cde". The template code is given below. Please complete it. Your code should construct the substring as well as store it in `resultSubStr` string. **[You will get no mark if you just print the substring without constructing it inside `resultSubStr`.]** **(15)**

```c
#include <stdio.h>

int main()
{
    char inputStr[101];     // input string
    char resultSubStr[101]; // result substring
    int startIdx;           // start index
    int length;             // length of the substring

    gets(inputStr);
    scanf(" %d %d", &startIdx, &length);

    // add your code here

    printf("%s", resultSubStr);
    return 0;
}
```

8. Write a C program that tales an array as input (first take the array size) and check whether it is sorted or not? If it is sorted in ascending order, then print "Sorted" and exit the program, otherwise print "Not Sorted" then sort it and finally print the sorted array. Sample input and output are given below- **(15)**

Input	Output
5 1 3 6 8 9	Sorted
5 1 6 3 9 8	Not Sorted 1 3 6 8 9

9. Implement the following grading system using switch statement in C programming language. **You can not use any if-else statement, and you do not need to validate the input mark.** **(15)**

Mark Range	Grade
0-39	F
40-49	D
50-54	C
55-59	B-
60-64	B
65-69	B+
70-74	A-
75-79	A
80-100	A+

SECTION – B

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

10. (a) (I) Define a structure "MyDate" in C to represent a date of a year. Use enumeration for the month field of the date. You should use bit-field to use memory as efficiently as possible. You can assume the maximum value of the year will be 2050. **(7+8=15)**

(II) Write a function which will take two "MyDate" type structures as parameters and will return the number of days, months, and years between the two dates. You should define another structure to return the difference in the specified format.

(b) Write a function in C to left circular shift or left rotate an integer by a specific amount. The bits that get shifted out on the left get shifted back in on the right. The function should take the integer and the amount by which the integer will be rotated as parameters and return the resulting integer after the rotation. **(13)**

Contd P/5

CSE 109/EEE

Contd ... Q. No. 10

(c) What will be the output of the following C program? **(7)**

```
#include <stdio.h>
typedef union{
    int i;
    char c;
    double d;
} Foo;

int main()
{
    int i=10;
    double d=5.6;
    char c='x';
    Foo f;
    f.i=i;
    f.d=d;
    f.c=c;
    printf("%ld\n",sizeof(f));
    if(f.i==i)
        printf("i is set to %d\n",i);
    if(f.d==d)
        printf("d is set to %lf\n",d);
    if(f.c==c)
        printf("c is set to %c",c);
    return 0;
}
```

11. (a) Suppose in your computer, you have the following text file "pollution.txt" in the directory "C:\Users\Della\Documents". The contents of that file are given below. **(20)**

NOTHING is more important to life than breathing but increasing air pollution is becoming a dangerous concern over breathing freely. Toxic air is now one of the biggest environmental threats for people who live in Dhaka city because we all already know this city has been ranked as the most air polluted city on the earth.

Write a program in C to replace the word "important" with "crucial" of that text file. Your program should work from any directory of that computer.

(b) Consider the following code in C++: **(5+3+7=15)**

```
#include <iostream>
using namespace std;
class C{
public:
    static string x;
    int y;
    static void printVars()
    {
        cout<<x<<" "<<y<<endl;
    }
};
string C::x="something";
int main()
{
    C o1,o2;
    o1.y=5;
    o2=o1;
    o1.printVars();
    o2.printVars();
    o2.y=10;
    o2.x="something else";
    o1.printVars();
    o2.printVars();
    return 0;
}
```

Contd P/6

CSE 109/EEE

Contd ... Q. No. 11(b)

(I) What is wrong with the function "printVars()"? Explain.

(II) Rewrite the function "printVars()" so that it prints the variables x and y properly.

(III) After the fix, what will be the output of the program?

12. (a) Briefly explain the differences between the public, private and protected members of a class. **(5)**

(b) Consider the following incomplete class and main function in C++: **(3+5+3+9=20)**

```
#include <iostream>
using namespace std;
class C{
private:
    int *x;
public:
    void Print(){
        cout << *x << endl;
    }
    C f(C o){
        *o.x= 10;
        return o;
    }
};
int main()
{
    C o1(5);
    C o2=o1;
    o1.f(o2).Print();
    o1.Print();
    o2.Print();
    return 0;
}
```

(I) Write a constructor for the class C that will take an integer as input and store the value of that integer in x;

(II) After you add the constructor mentioned in I, what will be the output of the program?

(III) Add a proper destructor for the class C to deallocate the memory of x.

(IV) After you add the destructor in III, will the program run properly? If not, explain the reason, and suggest a fix. Also, write the output of the program after the fix.

Contd P/7

CSE 109/EEE
Contd ... Q. No. 12

(c) Consider the following incomplete class and main function in C++: **(5+5=10)**

```
#include <iostream>
using namespace std;
class Person{
private:
    int age;
public:
    Person(int age){
        this->age=age;
    }
    void printAge(){
        cout<<age<<endl;
    }
};
int main()
{
    Person p1(15);
    Person p2=p1;
    (p2++).printAge();
    p2.printAge();
    if(p2>p1)
        cout<<"p2 is older"<<endl;
    else if(p1>p2)
        cout<<"p1 is older"<<endl;
    else
        cout<<"They are of equal age"<<endl;
    return 0;
}
```

Overload the post increment (++) and the relational operator(s) of the Person class. The post increment operator should do post increment of the age of that person and the relational operator should compare two persons based on their ages. After you overload the two operators, the output should be:

15

16

p2 is older

13. (a) When and why should you write a virtual destructor? **(7)**

(b) What will be the output of the following code? **(14)**

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Contd ... Q. No. 13(b)

```
#include <iostream>
using namespace std;
class A{
public:
    A(){ cout<<"Constrctor of class A"<<endl; }
    void f1(){ cout<<"A's f1"<<endl; }
    virtual void f2(){ cout<<"A's f2"<<endl; }
    ~A(){ cout<<"Destructor of class A"<<endl; }
};
class B : public A{
public:
    B(){ cout<<"Constrctor of class B"<<endl; }
    virtual void f1(){ cout<<"B's f1"<<endl; }
    virtual void f2(){ cout<<"B's f2"<<endl; }
    ~B(){ cout<<"Destructor of class B"<<endl; }
};
void fval(A a){
    a.f1();
    a.f2();
}
void fref(A &a){
    a.f1();
    a.f2();
}
void fptr(A *a){
    a->f1();
    a->f2();
}
int main()
{
    A *a1,*a2;
    a1= new A();
    a2= new B();
    a1->f1(); a1->f2();
    a2->f1(); a2->f2();
    fval(*a1); fref(*a1); fptr(a1);
    fval(*a2); fref(*a2); fptr(a2);
    delete a1; delete a2;
    return 0;
}
```

(c) I. Write an abstract class "Equilateral" which should have a protected member variable "side" and a pure virtual function "getArea()". The class should have one and only constructor which takes a value as parameter and sets the member variable "side" to that value. Note that, you are not allowed to write any other methods or constructors for this class. **(14)**

Contd P/9

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Contd ... Q. No. 13(c)

II. Write a class "Square" which publicly inherits the class "Equilateral". Override necessary methods so that the following main function works properly and generate the desired output. The formula to calculate the area of a square is (*side* × *side*).

III. Write a class "Triangle" which publicly inherits the class "Equilateral". Override necessary methods so that the following main function works properly and generate the desired output. The formula to calculate the area of an equilateral triangle is ($\frac{3}{4}$ × side × side).

```
#include <iostream>
using namespace std;
// write the above-mentioned classes
int main()
{

    Equilateral *e1,*e2;
    e1= new Square(3);
    e2= new Triangle(5);
    cout<<e1->getArea()<<endl;
    cout<<e2->getArea()<<endl;
    delete e1;
    delete e2;
    return 0;
}
```

Output:
9
18.75

L-1/T-1/EEE Date : 02/04/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2021-2022

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) A function is defined by **(12)**

$$f(x)=\begin{cases}\dfrac{1}{x+2}, & x<-2\\ x^2-5, & -2<x\le 3\\ \sqrt{x+13}, & x>3\end{cases}$$

Discuss the continuity and differentiability of $f(x)$ at $x=-2$. Sketch the graph of $f(x)$.

(b) A camera mounted at a point 3000 ft from the base of a rocket launching pad. If the rocket is rising vertically at 880 ft/s when it is 4000 ft above the launching pad, how fast must the camera elevation angle change at the instant to keep the camera aimed at the rocket? **(10)**

(c) State Leibnitz's theorem. If $y=(\sinh^{-1}x)^2$, show that **(13)**

$(1+x^2)y_{n+2}+(2n+1)xy_{n+1}+n^2y_n=0$, Also find $y_n(0)$.

2. (a) compute: $\lim\limits_{x\to 2}\left(\dfrac{1}{x-2}-\dfrac{1}{\ln(x-1)}\right)$. **(11)**

(b) State Euler's theorem on homogenous functions. If $u=\log_e\left(\dfrac{x^4+y^4}{x+y}\right)$, then find $x\dfrac{\partial u}{\partial x}+y\dfrac{\partial u}{\partial y}$. **(12)**

(c) Write down the Taylor's finite series with Lagrange's form of remainder. Expand $\sin x$ in powers of $\left(x-\dfrac{\pi}{2}\right)$ in finite series with the form of Lagrange's remainder. **(12)**

3. (a) A box with a square base is taller than its wide. In order to send the box through the U.S. mail, the height of the box and the perimeter of the base can sum to no more than 108 in. What is the maximum volume for such a box? **(11)**

Contd P/2

Contd ... Q. No. 3

(b) State Mean value theorem with its geometrical interpretation. Show that if $(0 < u < v)$, then $\frac{v-u}{1+v^2} < \tan^{-1} v - \tan^{-1} u < \frac{v-u}{1+u^2}$. Also show that $\frac{\pi}{4} + \frac{3}{25} < \tan^{-1}\left(\frac{4}{3}\right) < \frac{\pi}{4} + \frac{1}{6}$. **(12)**

(c) Find the pedal equation of the curve $r^n = a^n \cos n\theta$. **(12)**

4. (a) Show that the condition that the curves $x^{\frac{2}{3}} + y^{\frac{2}{3}} = c^{\frac{2}{3}}$ and $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ may touch is $a + b = c$. **(11)**

(b) Find the curvature of $x = 4\cos t$, $y = 3\sin t$. At what point on this ellipse does the curvature have the greatest and the least values? What are the magnitudes? **(12)**

(c) Find the asymptotes of $y^2(2a - x) = x^3$ and also trace the curve. **(12)**

SECTION – B

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

5. Workout the following:

(a) $\int \frac{1}{(1+x)^3\sqrt{x^2+x+1}}\,dx$ **(10)**

(b) $\int \sqrt{\tan x}\,dx$ **(10)**

(c) $\int \frac{dx}{a + b\cos x}$; discuss for $a > b$, $a < b$ and $a = b$. **(15)**

6. (a) Find an equation of the curve for each point (x, y) in which the slope of the curve is $-\sin x$ and the curve passes through the point $(0, 2)$. **(12)**

(b) Use definite integral to compute **(12)**

$$\lim_{n\to\infty}\left\{\left(2+\frac{1^2}{n^2}\right)^{1/n^2}\left(2+\frac{2^2}{n^2}\right)^{2/n^2}\left(2+\frac{3^2}{n^2}\right)^{3/n^2}\cdots\cdots\left(2+\frac{n^2}{n^2}\right)^{n/n^2}\right\}$$

(c) Find the value of the improper integral $\int_1^\infty \frac{\sqrt{x}}{(1+x)^2}\,dx$. **(11)**

Contd P/3

MATH 157/EEE

7. (a) Find a reduction formula for $I_n = \int \sin^n x\, dx$. Develope Walli's formula for the definite integral $\int_0^{\pi/2} \sin^n x\, dx$. Hence evaluate $\int_0^{\pi/2} \sin^5 x\, dx$. **(15)**

   (b) Find the values of the followings: **(20)**

   (i) $\Gamma(1/2)$,

   (ii) $\Gamma(8/3)$,

   (iii) $\Gamma(-11/2)$,

   (iv) $\beta(x, 1)$

   (v) $\Gamma(5/4) \cdot \Gamma(-5/4)$.

8. (a) Find the total area interior to $y^2 = 2ax - x^2$ and exterior to $y^2 = ax$ lying in the first quadrant. **(13)**

   (b) Use cylindrical shells to find the volume of the solid generated when the region R under $y = x^2$ over the interval [0, 2] is revolved about the line $y = -1$. **(11)**

   (c) Find the area inside the circle $r = \sin\theta$ and outside the cardioid $r = 1 - \cos\theta$. **(11)**

L-1/T-1/EEE Date : 03/05/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2021-2022

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) If $Re\{f'(z)\} = 3x^2 - 4y - 3y^2$, then find the analytic function $f(z)$, where $f(0) = -1$ and $f(1) = 2$. **(15)**

   (b) For any complex number z if $|z^2 - 1| = |z^2| + 1$, then show that z lies on an imaginary axis. **(10)**

   (c) Test the analyticity of the function $f(z) = \sinh 4z$ and find its derivative. **(10)**

2. (a) Write down Cauchy-Riemann equations in polar form. Test the differentiability of the function $f(z) = e^{-\theta}\cos(\ln r) + ie^{-\theta}\sin(\ln r)$, $(r > 0, 0 < \theta < 2\pi)$ in the indicated domain and hence show that $f'(z) = i\dfrac{f(z)}{z}$. **(20)**

   (b) Show that $v = \tan^{-1}\dfrac{y}{x}$ is a harmonic function. Find an analytic function $f(z)$ in which $v(x, y)$ is the imaginary part. Also express $f(z)$ in terms of z. **(15)**

3. (a) Evaluate the integral $\int_{(0,4)}^{(2,5)} \left(3y + 2x^2\right)dx + \left(2x - 3y\right)dy$ along the parabola $x = 2t$, $y = t^2 + 4$. **(15)**

   (b) Using Cauchy's Integral formula evaluate the integral $\oint_C \dfrac{1}{\left(z^2+1\right)\left(z^2+9\right)}dz$, where C is the square whose sides lie along the lines $x = \pm 2$, $y = \pm 2$ described in the positive sense. **(20)**

4. (a) Express $f(z) = \dfrac{4z+3}{z(z-3)(z+2)}$ in a Laurent series valid in the region $2 < |z| < 3$. **(15)**

   (b) Evaluate the integral $\oint_C \dfrac{2z^2 - z + 1}{(2z-1)(z+1)^2}dz$ by Cauchy's Residue theorem, where $C: r = 2\cos\theta, 0 \le \theta \le 2\pi$. **(20)**

Contd P/2

MATH 159/EEE

SECTION – B

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

5. (a) Examine whether the vectors $\vec{A} = \hat{i} - 3\hat{j} + 2\hat{k}$, $\vec{B} = 2\hat{i} - 4\hat{j} - \hat{k}$, $\vec{C} = 3\hat{i} + 2\hat{j} - \hat{k}$ are linearly independent or linearly dependent. If possible, find a relation among them. **(10)**

   (b) Find a set of vectors reciprocal to the set **(10)**

   $2\hat{i} + 3\hat{j} - \hat{k}, \hat{i} - \hat{j} - 2\hat{k}, -\hat{i} + 2\hat{j} + 2\hat{k}$.

   (c) Given points P(2, 1, 3), Q(1, 2, 1), R(−1, −2, −2) and S(1, −4, 0), find the shortest distance between lines PR and QS. **(15)**

6. (a) Define curvature and torsion. Find equation for the tangent to the curve $x = 3\cos t$, $y = 3\sin t$, $z = 4t$ at any point $t = \pi$. **(12)**

   (b) Find the most general differentiable function $f(r)$ so that $f(r)\,\vec{r}$ is solenoidal. **(10)**

   (c) Show that $\vec{E} = \dfrac{\vec{r}}{r^2}$ is irrotational. Find ϕ such that $\vec{E} = -\vec{\nabla}\phi$ and such that $\phi(a) = 0$ where $a > 0$. **(13)**

7. (a) Evaluate $\iint_S y^2 z^2 \, dS$ wher S is the part of the cone $z = \sqrt{x^2 + y^2}$ that lies between $z = 1$ and $z = 3$. **(17)**

   (b) If $\vec{F}(x, y, z) = (2x^2 - 3z)\hat{i} - 2xy\hat{j} - 4x\hat{k}$, evaluate $\iiint_V div\,\vec{F}\,dV$, where V is the closed region bounded by the planes $x = 0$, $y = 0$, $z = 0$ and $x + 2y + 3z = 6$. **(18)**

8. (a) Write down two applications of Green's theorem in the plane. **(15)**

   Evaluate $\int_C (xy + y^2)dx + x^2 dy$ where C is the closed curve of the region bounded by $y = x$ and $y^2 = x$.

   (b) State Gauss's Divergence theorem. Verify the Divergence theorem for **(20)**

   $\vec{F} = 4x\hat{i} - 2y^2\hat{j} + z^2\hat{k}$

   taken over the region bounded by $x^2 + y^2 = 4$, $z = 0$ and $z = 5$.

L-1/T-1/EEE **Date : 09/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2021-2022

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) What is effective mass of a spring in the spring mass system. Explain graphically how to determine the effective mass of the spring in the spring mass system. **(8)**

(b) If a spring of mass m be clamped vertically at a point and loaded with a mass m_0 at the other end, then find out the expression for effective mass of the spring mass system. **(20)**

(c) A block of mass m moving horizontally at speed v collides with a spring of non-linear restoring force, $F = -k_1x - k_2x^3$ on a frictionless surface, where the symbols have their usual meanings. Find the maximum compression, x, of the spring. **(7)**

2. (a) What is forced vibrations? How does the amplitude of forced vibrations depend on natural frequency of an oscillator? **(8)**

(b) Establish the different equation of forced vibrations for an oscillator. Solve this equation and hence discuss the resonance and sharpness of resonance. **(20)**

(c) A harmonic oscillator of quality factor 20 is subjected to a sinusoidal applied force of frequency two 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. **(7)**

3. (a) What are the reverberation and reverberation time? **(8)**

(b) Derive the Sabine's reverberation formula to express the rise and falls of sound in an auditorium. **(20)**

(c) The volume of an auditorium is 1200 m^3. The area of wall, floor and ceiling are 240, 160 and 130 cm^2, respectively. The average absorption coefficient of wall, ceiling and floor are 0.03, 0.80, and 0.06, respectively. Calculate the average sound absorption coefficient and the reverberation time. **(7)**

4. (a) What is diffraction of light? Discuss the Fraunhofer diffraction due to a single slit. **(8)**

(b) Derive an expression for the intensity distribution function due to the Fraunhofer type of diffraction produced by a narrow slit. Show that the intensity of the second secondary maximum is roughly 1.6% of that of the principal maximum. **(20)**

(c) In Fraunhofer diffraction pattern due to a narrow slit, a screen is placed 2 m away from the lens to obtain the pattern. If the slit width is 0.2 mm and the first minimum lie 5 mm on either side of the central maximum, find the wavelength of light. **(7)**

Contd P/2

PHY 121/EEE

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.
Symbols have their usual meanings.

5. (a) What is Fresnel's biprism? Explain the formation of coherent sources in the case of biprism. **(10)**

(b) Briefly discuss the effect of introducing a transparent thin film in the path of one of the interference beams in a biprism experiment. Deduce an expression for the displacement of the fringes. Show how this method is used for finding the thickness of a thin transparent film. **(18)**

(c) In a biprism experiment, the eyepiece is placed at a distance of 1.2 m from the source. The distance between the virtual sources was found to be 7.5×10^{-4} m. Find the wavelength of light, if the eyepiece is to be moved transversely through a distance of 1.9 cm for 20 fringes. **(7)**

6. (a) Explain the defect curvature of the field and how can it be minimized for a system of lenses. **(10)**

(b) Derive the condition of achromatism for two thin lenses placed in contact. Discuss the validity of the condition for the choice of the type and material of the lenses. Draw an objective lens which is free from both the chromatic and spherical aberration. **(18)**

(c) The dispersive powers for crown and flint glasses are in the ratio of 1:2. Calculate the focal lengths of the lenses made of crown and flint glasses which form an achromatic combination of focal length 20 cm when placed in contact. **(7)**

7. (a) From kinetic theory of glass, find an expression for pressure exerted by a gas in terms of density and mean square velocity of the gas. **(12)**

(b) Define degrees of freedom of a gas. Show that for a gas possessing n degrees of freedom $\gamma = 1 + \frac{2}{n}$, where symbols have their usual meaning. **(7)**

(c) Apply the first law of thermodynamics to deduce Mayer's relation. **(12)**

(d) A Carnot engine has an efficiency of 22.0%. It operates between reservoirs differing in temperature by 75.0 K. Calculate the temperature of the lower-temperature and higher-temperature reservoir? **(4)**

8. (a) Define the thermodynamic potentials. From them derive Maxwell's four fundamental thermodynamic relations. **(18)**

(b) Show that for a Van der Waals' gas, $C_P - C_V = R\left(1 + \frac{2a}{VRT}\right)$, where symbols have their usual meaning. **(10)**

(c) Explain how a reversible cyclic process can be represented by a cascade of Carnot cycles. **(7)**
