- **Heap.h**

```
/*
 * Heap.h
 * Created on: Nov 28, 2020
 * Author: Megha Sonavane
 */

#ifndef HEAP_H_
#define HEAP_H_

class Heap {
public:
	Heap();
	void buildHeap(int[],int);
	void heapSort(int[],int);
	void heapify(int[],int,int);
	void display(int[],int);
	virtual ~Heap();
};

#endif /* HEAP_H_ */
```

- **Heap.cpp**

```
/*
 * Heap.cpp
 *  Created on: Nov 28, 2020
 *  Author: Megha Sonavane
 */
#include<iostream>
#include "Heap.h"
using namespace std;

Heap::Heap() {
	// TODO Auto-generated constructor stub

}
//============build heap==============================
void Heap::buildHeap(int arr[],int n){
	for(int i=n/2;i>=0;i--)
		heapify(arr,n,i);
}
//============Heapify method===========================
void Heap::heapify(int arr[],int n,int i)
{
	int largest=i;
	//for left
	int left=2*i+1;
	//for right
	int right=2*i+2;

	if(left<n && arr[left]>arr[largest])
		largest=left;
	if(right<n && arr[right]>arr[largest])
		largest=right;
	if(largest!=i)
	{
		swap(arr[i],arr[largest]);
		heapify(arr,n,largest);
	}
}
//=================heap sort====================================
void Heap::heapSort(int arr[],int n){
	int pass=1;
	for(int i=n-1;i>=0;i--){
		swap(arr[i],arr[0]);
		heapify(arr,i,0);
		cout<<endl<<"Pass "<<pass<<endl;
		display(arr,n);
```

```
                pass++;
        }
}
//=============display heap======================================
void Heap::display(int arr[],int n){
        for(int i=0;i<n;i++){
                cout<<arr[i]<<" ";
        }
}

Heap::~Heap() {
        // TODO Auto-generated destructor stub
}
```

- **Assignment9.cpp**

```
//============================================================================
// Name        : Assignment9.cpp
// Author      : Megha Sonavane
// Description : Heap Sort
//============================================================================

#include <iostream>
#include "Heap.h"
#define MAX 20
using namespace std;

int main() {
	Heap h;
	int n,ch;
	int arr[MAX];
	cout<<"Heap Data Struture"<<endl;
	do{
		cout<<"Enter number of elememts(Max 20):";
		cin>>n;
	}while(n<1||n>20);

	cout<<"Enter "<<n<<" elements:";
	for(int i=0;i<n;i++)
		cin>>arr[i];

	do{

	cout<<endl<<"========================================================================="<<endl;
		cout<<"\t1:Heapify"<<endl<<"\t2:Heap Sort"<<endl<<"\t3:Insert new element to array"<<endl<<"\t0:Exit"<<endl;
		cout<<"\tEnter choice:";
		cin>>ch;

	cout<<"==========================================================================="<<endl;
		switch(ch){
		case 1:
			//========Build heap====================
			h.buildHeap(arr,n);
			h.display(arr,n);
			break;
		case 2:
				//======Heap sort======================
				h.buildHeap(arr,n); //build heap
				h.heapSort(arr,n); //sort heap
				break;
			case 3:
				//=======insert new element to heap=====
				if(n==20)
					cout<<"Sorry..no space available..."<<endl;
				else{
					int data;
					cout<<"\tEnter element:";
					cin>>data;
					arr[n]=data;
					n=n+1;
					cout<<"\tElement inserted..."<<endl;
				}

				break;
			case 0:
				cout<<"\tThank you...";
				break;
			default:
				cout<<"\tInvalid choice.."<<endl;
			}
		}while(ch!=0);
		return 0;
}
```

- **<u>Output:</u>**

Partially sorted array:

```
Heap Data Struture
Enter number of elememts(Max 20):5
Enter 5 elements:5
12
9
3
10

============================================================
        1:Heapify
        2:Heap Sort
        3:Insert new element to array
        0:Exit
        Enter choice:1
============================================================
12 10 9 3 5
============================================================
        1:Heapify
        2:Heap Sort
        3:Insert new element to array
        0:Exit
        Enter choice:2
============================================================

Pass 1
10 5 9 3 12
Pass 2
9 5 3 10 12
Pass 3
5 3 9 10 12
Pass 4
3 5 9 10 12
Pass 5
3 5 9 10 12
============================================================
        1:Heapify
        2:Heap Sort
        3:Insert new element to array
        0:Exit
        Enter choice:3
============================================================
        Enter element:4
        Element inserted...
```

```
=================================================================
     1:Heapify
     2:Heap Sort
     3:Insert new element to array
     0:Exit
     Enter choice:2
=================================================================

Pass 1
10 5 9 3 4 12
Pass 2
9 5 4 3 10 12
Pass 3
5 3 4 9 10 12
Pass 4
4 3 5 9 10 12
Pass 5
3 4 5 9 10 12
Pass 6
3 4 5 9 10 12
=================================================================
     1:Heapify
     2:Heap Sort
     3:Insert new element to array
     0:Exit
     Enter choice:0
=================================================================
     Thank you...
```

Completely Sorted Array:

```
Heap Data Struture
Enter number of elememts(Max 20):5
Enter 5 elements:3
5
10
9
12

=========================================================================
        1:Heapify
        2:Heap Sort
        3:Insert new element to array
        0:Exit
        Enter choice:1
=========================================================================
12 9 10 3 5
=========================================================================
        1:Heapify
        2:Heap Sort
        3:Insert new element to array
        0:Exit
        Enter choice:2
=========================================================================

Pass 1
10 9 5 3 12
Pass 2
9 3 5 10 12
Pass 3
5 3 9 10 12
Pass 4
3 5 9 10 12
Pass 5
3 5 9 10 12
=========================================================================
        1:Heapify
        2:Heap Sort
        3:Insert new element to array
        0:Exit
        Enter choice:0
=========================================================================
        Thank you...
```

Completely unsorted array:

```
Heap Data Struture
Enter number of elememts(Max 20):5
Enter 5 elements:12
10
9
5
3

=====================================================================
	1:Heapify
	2:Heap Sort
	3:Insert new element to array
	0:Exit
	Enter choice:1
=====================================================================
12 10 9 5 3
=====================================================================
	1:Heapify
	2:Heap Sort
	3:Insert new element to array
	0:Exit
	Enter choice:2
=====================================================================

Pass 1
10 5 9 3 12
Pass 2
9 5 3 10 12
Pass 3
5 3 9 10 12
Pass 4
3 5 9 10 12
Pass 5
3 5 9 10 12
=====================================================================
	1:Heapify
	2:Heap Sort
	3:Insert new element to array
	0:Exit
	Enter choice:0
=====================================================================
	Thank you...
```